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Energy Pilot Studies - Integrating Report. Geothermal Solar Rational Use of Energy (Conservation) Automotive Propulsion Systems

NATO Committee on the Challenges of Modern Society, Brussels (Belgium)

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16. ABSTRACT

This report represents in part the results of an international energy workshop held in Italy in July, 1978, for the purposes of assessing the accomplishments of the four pilot studies and integrating their findings. The four studies are; Geothermal, Solar, Rational Use of Energy, Automotive Propulsion Systems.

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COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY
NORTH ATLANTIC TREATY ORGANIZATION

ENERGY PILOT STUDIES

Geothermal
Solar
Rational Use Of Energy (Conservation)
Automotive Propulsion Systems

INTEGRATING REPORT

CCMS Plenary Meeting
Brussels
October 1978

Submitted By
UNITED STATES OF AMERICA

PREFACE AND ACKNOWLEDGEMENTS

This is an integrating report on four separate Pilot Studies conducted under the auspices of the Committee on the Challenges of Modern Society, a part of the North Atlantic Treaty Organization. The studies were conducted over a five year period by experts and officials from many nations. The success of the studies is due to the expertise, dedication and goodwill of the individual participants and the nations which they represented. The United States, as Pilot Country for the studies, expresses its gratitude for their efforts.

Support for the studies was provided by the many governments, both members and non-members of NATO, which contributed personnel, travel funds and project funding. Several U.S. government agencies provided support for the CCMS work. Funding was provided by the U.S. National Science Foundation for administrative and logistical support to the several agencies involved in the project, and particularly to the management of the energy programs carried out under the auspices of the U.S. Representative to the Committee on the Challenges of Modern Society. Without this organizational and financial support, the studies could not have been conducted.

This report represents in part the results of an international workshop held in Italy in July, 1978, for the purposes of assessing the accomplishments of the four Pilot Studies, integrating their findings, and considering general international cooperation in energy programs. It also represents an effort to reflect the many views expressed in the Studies and Workshop. As such, it should not be construed to represent the official position of either the United States Government or the other participants of the Studies or Workshop, nor should it be construed as a formal set of agreed-upon conclusions.

(This report was prepared by Kendall Associates of San Francisco under contract to the Office of Research and Development, U.S. Environmental Protection Agency. Contract supervision was provided by the Office of the U.S. Coordinator for NATO/CCMS Activities.)

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Appendix - List of CCMS Energy Pilot Study Reports

I. EXECUTIVE SUMMARY

The Committee on the Challenges of Modern Society (CCMS) was created as a committee of the North Atlantic Treaty Organization (NATO) in 1969. Its purpose is to exchange views and experience among nations as a means of creating a better environment for their societies with the objective of stimulating actions by member governments. The CCMS approach is informal and voluntary. Each project is led by a "pilot" country and participation in CCMS projects is open to non-NATO nations. This is a report on four separate CCMS Energy Pilot Studies, conducted with the United States as Pilot Country.

This report is a summary of the final report from each Energy Pilot Study as well as an integration of the results of all four. The four Pilot Studies are described below:

1. Geothermal Energy

   This project focused on exchanging information and developing on-going programs for computer-based data and information exchange, direct use of geothermal energy, brine disposal techniques, small geothermal power plants, and hot dry rock technology.

2. Solar Energy

   This project focused on exchanging information related to research projects and on-going programs in solar heating and cooling of buildings. This Pilot Study also participated in some international R&D projects. Emphasis was given to reporting the performance results of solar heating and cooling systems as a means of encouraging wider use of solar technology.

3. Rational Use of Energy (Conservation)
   This project focused on technological and managerial techniques for conserving energy or for shifting energy use away from fossil fuels, especially petroleum. The project consisted of four subprojects as described below.

   A. Industrial International Data Base

      This subproject developed and applied a methodology for comparing energy use for similar industrial processes in different nations. Data for the cement, steel, plastics and brewing industries were collected.

   B. Modular Integrated Utility Systems

This subproject exchanged information and conducted pilot programs on more energy efficient ways to deliver utilities (electricity, water, heating, cooling, liquid and solid waste disposal) to residences.

C. Climatic Conditions and Test Reference Year

This subproject exchanged information and developed a methodology on ways to measure the impact of weather and climate on energy consumption and on application of new energy technologies—especially solar technologies.

D. Electric Utility Load Management

This subproject exchanged information on methods of reducing daily and seasonal peaks in the demand for electricity as a means of conserving valuable fossil fuels.

4. Automotive Propulsion Systems (APS)

This project originated as part of the CCMS Air Pollution Pilot Study which was completed in 1974. The APS Pilot Study focused on conducting international symposia to exchange information on improved engine efficiency, alternative fuels and safety for all highway vehicles.

The underlying themes for the Pilot Studies were:

- Conservation of all forms of energy.
- Concern that finite fossil fuel supplies are diminishing rapidly.
- The need to find significant new sources of energy.
- The need to decrease the dependence on imported fuels.
- Concern about the increasing environmental problems associated with energy systems.
- Concern about the especially difficult problems of energy availability in developing nations.

1.1 ACCOMPLISHMENTS

In general, the studies accomplished the following:

1. Information Exchange

   Participating countries exchanged information regarding technical problem definition, current R&D programs, successes and failures in past R&D efforts and plans for future work.

2. Influence on National Programs

   The world-wide, state-of-the-art assessments made possible through the information exchange allowed nations to establish useful energy programs. This was especially important in light of the increased concern resulting from the 1973 OPEC actions. The Pilot Studies provided needed information for establishing R&D priorities, budget levels, and regulatory parameters.

3. Establishment of International Communities

   Through the meetings, symposia and conferences conducted by each Pilot Study, informal internatinal communities of experts and expert organizations were established. These allow rapid and accurate dissemination of information on an informal, "as needed" basis. These communities will continue into the future.

4. Establishment of On-Going Organizations

   Many of the activities of the Pilot Studies have resulted in the establishment of permanent international activities on both a bilateral and multilateral basis. These range from an established computerized geothermal information system to biannual symposia on automotive propulsion systems.

5. Recommended National Actions

   The Pilot Studies have developed recommendations for consideration by nations when developing energy policies.

6. Recommended International Activities

   The Pilot Studies have recommended actions which could best be accomplished by various types of international organizations.

7. Identification of Key Issues

   Through information exchange and analysis, the Pilot Studies focused attention on defining and resolving key issues related to development and implementation of energy conservation and alternative energy programs.

8. Participation of Developing Nations

For some Pilot Studies, developing nations made substantial contributions which benefited both developed and developing nations.

The Pilot Studies made specific recommendations which are presented in Section 3.

1.2 INTEGRATING ISSUES

An Integrating Workshop was held in July, 1978 for the purpose of assessing the accomplishments of the four Pilot Studies, integrating their findings and considering general international cooperation in energy programs. The Integrating Group found the following integrating issues.

Conservation

The main theme of the four Pilot Studies and the Integrating Group was the conservation of energy and other natural resources through new technology and the improved efficiency of existing systems. The Integrating Group found that current energy conservation programs were not sufficient to achieve the high potential which exists within current economic and technological constraints.

Information Sharing

The Pilot Studies and the Integrating Group found that a substantial increase in the amount of international sharing of information on energy programs (including the CCMS Pilot Studies) could greatly accelerate the implementation of conservation programs.

Implementation Strategies

Acceptance of an emerging technology usually requires adjustments in existing attitudes, government regulations and business practices. At the same time, a successful technological innovation usually requires fairly close adherence to existing institutional factors such as cultural, social, economic and political norms. Many participants in the Integrating Group and the Pilot Studies concluded that national governments and international organizations must be fully cognizant of institutional factors when designing and conducting energy programs. They further concluded that more rapid

progress could be achieved in obtaining implementation of currently emerging technologies if more attention is paid to these factors.

An Emerging Issue - Designing Technology for Human Society

The Pilot Studies and the Integrating Group all point toward the fact that national and international organizations need to more systematically and consciously include environmental, cultural, and social considerations in programs which have been focused primarily on purely technical issues. It is becoming necessary to develop new technologies and modify existing ones so that they are suitable to satisfy the needs of society. Suitable technology, (sometimes called "appropriate technology") includes the concept of designing a technological application (including its size and complexity) to fit the overall circumstances to which it will be applied. Examples include using windmills for pumping irrigation water, using bicycles for urban transportation, or using low intensity heat sources for low heat requirements (such as direct geothermal applications).

Results of the Pilot Studies and the Integrating Workshop indicated mankind's need for development of decentralized and small-scale energy systems; simplified (but possibly technically elegant) methods for developing, delivering and using energy; applying "high quality" energy (natural gas or electricity) to the most necessary uses; and reducing the complexity and vulnerability of the entire energy system.

International cooperative activities, such as the CCMS and other organizations, can assist in gaining widespread acceptance of the suitable technology concept.

1.3 LESSONS LEARNED

The CCMS approach of flexibility and informality proved extremely useful for the Energy Pilot Studies. The success of the studies demonstrates that interntional energy R&D and exchange programs offer the opportunity for achieving results in an accelerated timeframe. The usefulness of these programs can be increased by the active participation by each nation involved.

2. THE COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY (CCMS)

The Committee on the Challenges of Modern Society (CCMS) was created in 1969 as a committee of the North Atlantic Treaty Organization (NATO) (Figure 2.1). It was established and directed to examine how to improve, in every practical way, the exchange of views and experience among the NATO countries in the task of creating a better environment for their societies and to consider specific problems of the human environment with the deliberate objective of stimulating action by member governments.

The basis of CCMS and its work program is to promote an effective and continuing exchange of information, technology and experience in order to pool the world's expertise and expand the base of knowledge, and to create a better human environment in all nations.

2.1 CCMS PILOT STUDY CONCEPT

The CCMS operates by a "pilot study" method where one country with interest agrees to take the lead or "pilot" role for each study. Each participating country contributes resources to carry out its own voluntarily accepted responsibilities in the project. At present the CCMS has thirteen pilot studies underway. They are as follows:

	Study	Pilot
1.	Advanced Wastewater Treatment	U.K.
2.	Disposal of Hazardous Wastes	FRG
3.	Solar Energy*	U.S.
4.	Geothermal Energy*	U.S.
5.	Rational Use of Energy (Conservation)*	
	- Industrial International Data Base	U.S. and Italy
	- Modular Integrated Utility Systems	U.S.
	- Climatic Conditions and Test Reference Year	Denmark
	- Electric Utility Load Management	U.S.
6.	Air Pollution Assessment Methodology and Modeling	FRG
7.	Automotive Propulsion/Low Pollution Power Systems *	U.S.
8.	Nutrition and Health	Canada

* Energy Pilot Study covered by this report.

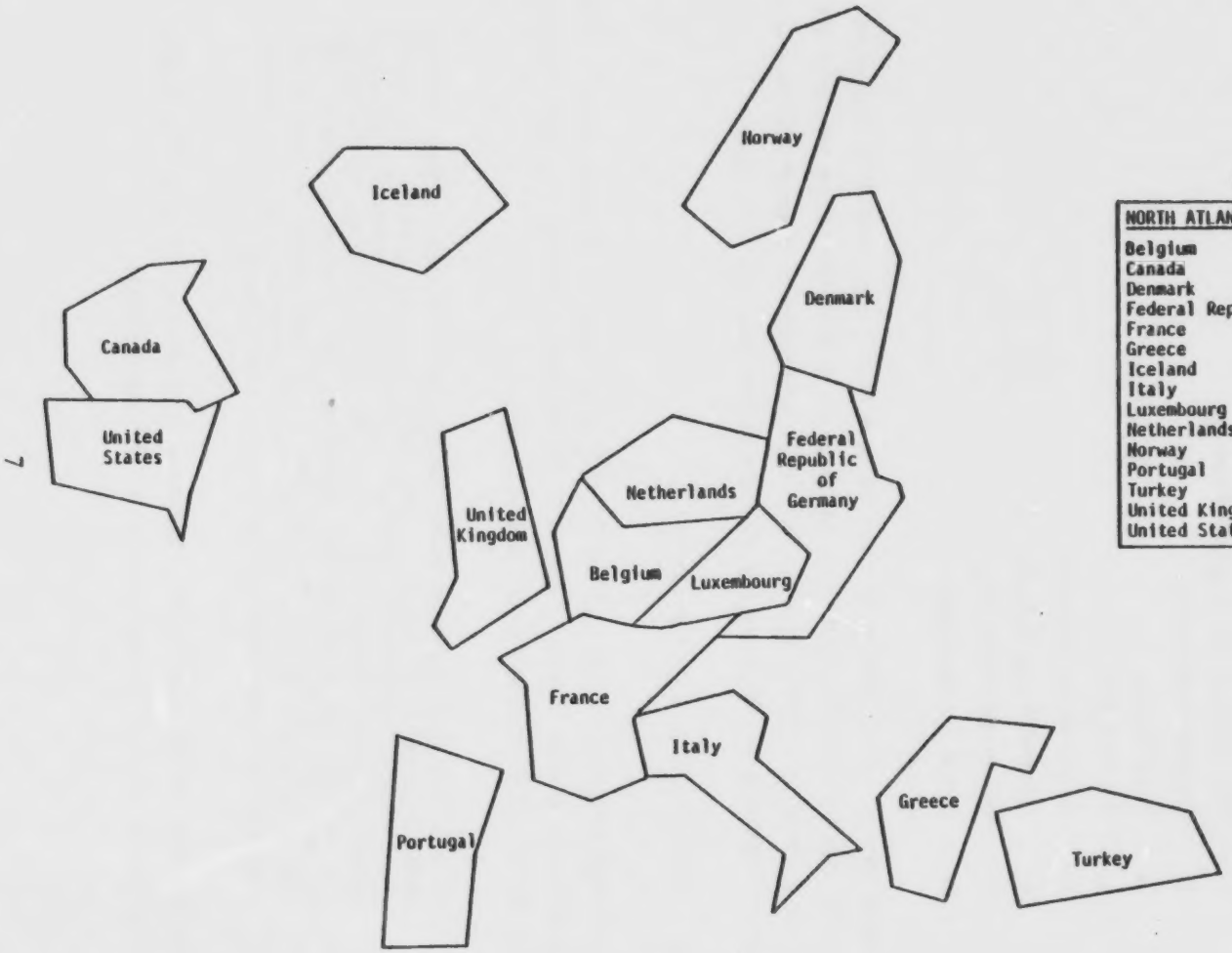

FIGURE 2.1

NORTH ATLANTIC TREATY ORGANIZATION

Belgium
Canada
Denmark
Federal Republic of Germany
France
Greece
Iceland
Italy
Luxembourg
Netherlands
Norway
Portugal
Turkey
United Kingdom
United States

9.	Remote Sensing in the Control of Marine Pollution	France
10.	Flue Gas Desulfurization	U.S.
11.	Drinking Water	U.S.
12.	Seismology and Earthquake Loss Reduction	Italy
13.	Emergency Medical Services	U.S.

The following pilot studies have been completed.

1. Environment and Regional Planning
2. Disaster Assistance
3. Road Safety
4. Air Pollution
5. Inland Water Pollution
6. Coastal Water Pollution
7. Advanced Health Care
8. Urban Transportation

Membership in CCMS studies is open to both NATO and non-NATO countries. The studies operate informally with open exchange of information among technical experts. By using the pilot country concept, CCMS does not require an international bureaucracy, thereby improving its flexibility and making possible lower operating costs.

2.2 CCMS ENERGY PILOT STUDIES

The Energy Pilot Studies began at the CCMS Plenary Session in Ottawa in April, 1973. In proposing the studies, Russell Train, U.S. CCMS Representative and then Chairman of the U.S. Council of Environmental Quality, stated,

> "One of the most urgent problems facing the world today is where to find adequate supplies of energy to fuel world economic growth. The future world demand for energy is expected to continue to increase. The principal source of present energy is fossil fuels and these are finite. By the end of the century, we must develop significant new sources of energy and decrease our dependence on fossil fuels . . . Energy supply however, is not the only problem. We must deal with the environmental problems of energy production and also make the conservation of energy a national priority."

These general themes cited by Mr. Train have been the foundation for four Energy Pilot Studies carried out over the past five years. The themes were:

- Conservation of all forms of energy.
- Concern that finite fossil fuel supplies are diminishing rapidly.
- The need to find significant new sources of energy.
- The need to decrease the dependence on imported fuels.
- Concern about the increasing environmental problems associated with energy systems.

In approving the pilot studies, the CCMS recognized the commonality of these themes for all nations and the immense endeavor associated with finding solutions to the problems underlying the themes. The CCMS format of informal, voluntary participation at the technical level was ideal for exchange of information, definition of problems and establishment of specific programs (usually outside NATO/CCMS).

Events subsequent to the establishment of the Energy Pilot Studies have emphasized the importance of the themes outlined by Mr. Train. The OPEC oil embargo of October, 1973, and the subsequent economic and political adjustments, have forced a profound reassessment of energy policies in every nation of the world. The Energy Pilot Studies have played a modest but supportive role during this reassessment process.

The Four Pilot Studies are described below.

1. Geothermal Energy

   This project focused on exchanging information and developing on-going programs for computer-based data and information exchange, direct use of geothermal energy, brine disposal techniques, small geothermal power plants, and hot dry rock technology.

2. Solar Energy

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- Climatic Conditions and Test Reference Year

  This subproject exchanged information and developed a methodology on ways to measure the impact of weather and climate on energy consumption and application of new energy technologies—especially solar technologies.

- Electric Utility Load Management

  This subproject exchanged information on methods of reducing daily and seasonal peaks in the demand for electricity as a means of conserving valuable fossil fuels.

4. Automotive Propulsion Systems (APS)

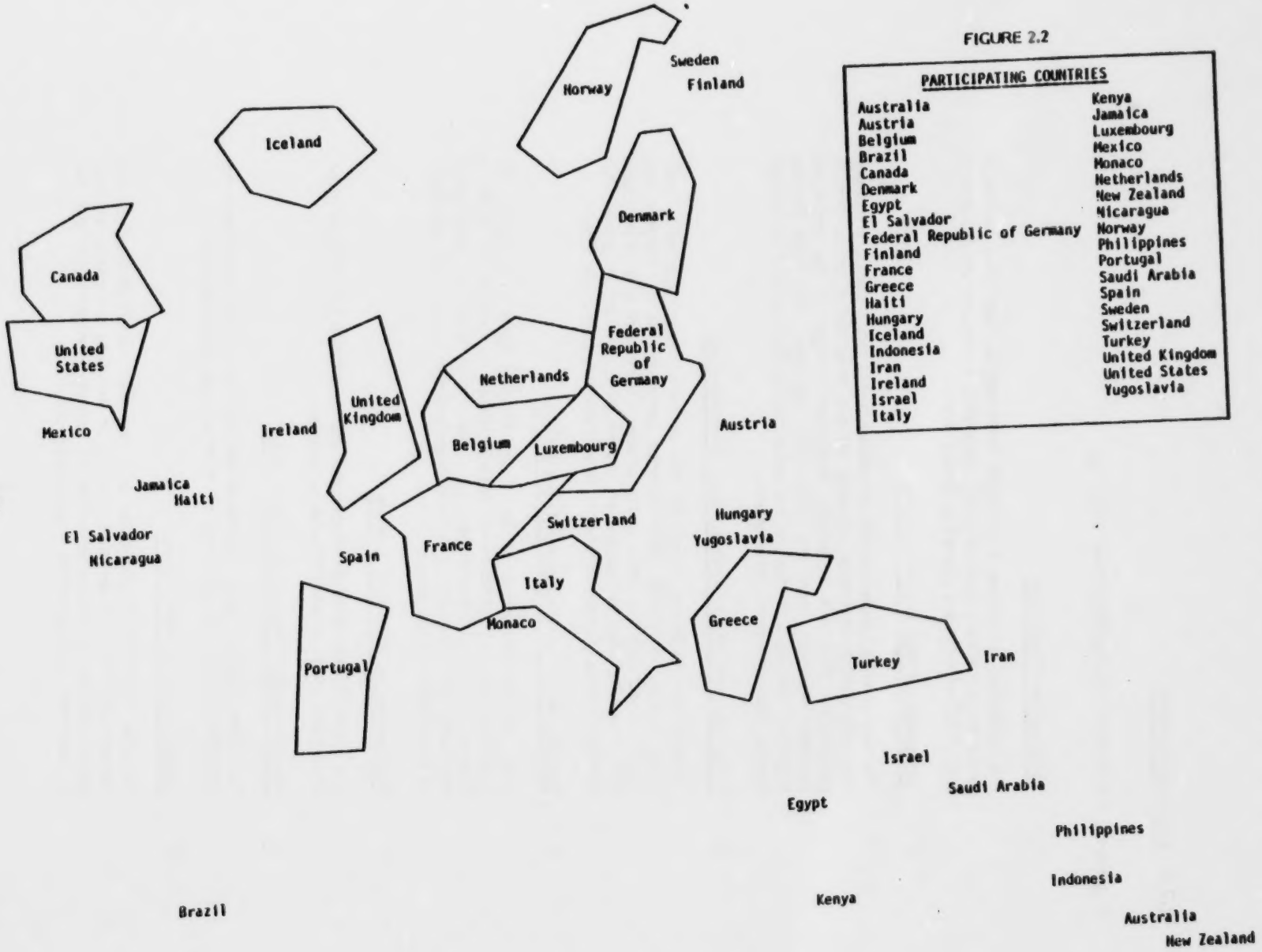
This project originated as part of the CCMS Air Pollution Pilot Study which was completed in 1974. The APS Pilot Study focused on conducting international symposia to exchange information on improved engine efficiency, alternative fuels and safety for all highway vehicles.

A summary of the results of each pilot study is presented in Section 3 of this report.

2.2.1 Participating Nations

Participation in the Pilot Studies included the fifteen NATO nations and twenty-four non-NATO nations as shown in Figure 2.2. In addition, other nations participated as observers. Participants included government officials as well as representatives from industry, academia and the scientific and engineering communities.

FIGURE 2.2



PARTICIPATING COUNTRIES

Australia	Kenya
Austria	Jamaica
Belgium	Luxembourg
Brazil	Mexico
Canada	Monaco
Denmark	Netherlands
Egypt	New Zealand
El Salvador	Nicaragua
Federal Republic of Germany	Norway
Finland	Philippines
France	Portugal
Greece	Saudi Arabia
Haiti	Spain
Hungary	Sweden
Iceland	Switzerland
Indonesia	Turkey
Iran	United Kingdom
Ireland	United States
Israel	Yugoslavia
Italy	

2.2.2 Accomplishments

In general, the studies accomplished the following:

1. Information Exchange

   Participating countries exchanged information regarding technical problem definition, current R&D programs, successes and failures in past R&D efforts and plans for future work.

2. Influence on National Programs

   The world wide, state-of-the-art assessments made possible through the information exchange allowed nations to establish useful energy programs. This was especially important in light of the increased concern resulting from the 1973 OPEC actions. The Pilot Studies provided needed information for establishing R&D priorities, budget levels, and regulatory parameters.

3. Establishment of an International Communities

   Through the meetings, symposia and conferences conducted by each Pilot Study, informal, international communities of experts and expert organizations were established. These contacts allow rapid and accurate dissemination of information on an informal, "as needed," basis. These communities will continue into the future.

4. Establishment of On-Going Organizations

   Many of the activities of the Pilot Studies have resulted in the establishment of permanent international activities on both a bilateral and multilateral basis. These range from an established computerized geothermal information system to biannual symposia on automative propulsion systems.

5. Recommended National Actions

   The Pilot Studies have developed recommendations for consideration by nations when developing energy policies.

6. Recommended International Activities

   The Pilot Studies have recommended actions which could best be accomplished by various types of international organizations.

7. Identification of Key Issues

   Through information exchange and analysis, the Pilot Studies the focused attention of decision makers on defining and resolving key issues related to implementation of energy conservation and the development of alternative energy programs.

8. Participation of Developing Nations

In some Pilot Studies, developing nations made substantial contributions which benefited both developing and developed countries.

2.2.3 Contribution Of The Pilot Studies

While the CCMS Energy Pilot Studies were not created to solve the problems associated with diminishing resources and political actions such as those of OPEC, it is useful to put the accomplishments of the study in the context of the current international energy situation.

The most current energy supply/demand balance for the industrialized, non-OPEC western nations was prepared by IEA in 1978. The energy balance is shown in Figure 2.3.[1] Demand is projected to grow from about the equivalent of 3 1/4 billion metric tonnes[2] of oil in 1976 to about 4 1/2 billion tonnes in 1985 and about 5 1/4 billion tonnes in 1990. Based on IEA's analysis of supplies, a "gap" between supply and demand of 200 to 600 million tonnes could exist in 1985. "This notional "gap" implies that there would be a strong upward pressure on the real price of imported oil in order to acheive the balance of demand with the forthcoming supply. A very tight market would also result in substantial uncertainty over the reliability of oil supply."[3] This "gap" can be reasonably assured to increase after 1985. Any reduction in the "gap" could reduce the pressure on price and relieve the uncertainty.

While it is neither possible nor desirable to attempt a comprehensive analysis of the contribution of the CCMS Energy Pilot Studies toward reducing the "gap," the general description of the contributions presented below shows that the results of the studies, if implemented, could make a significant contribution.

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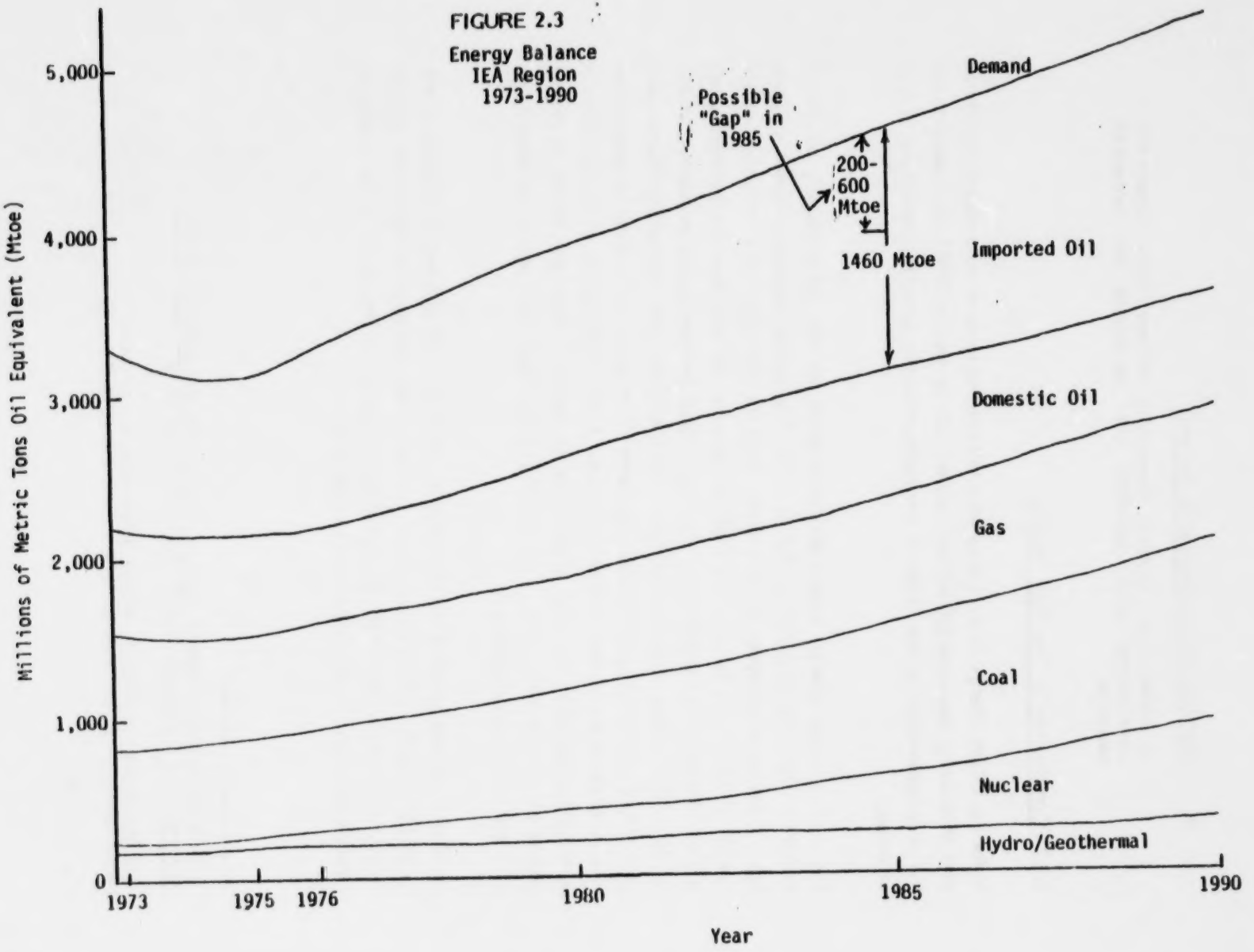
[1] International Energy Agency. Energy Policies and Programmes of IEA Countries - 1977 Review. OECD. Paris, 1978. pp. 52-54.

[2] For consistency of units, all energy is expressed in equivalent metric tonnes of oil (one metric tonne = about 6.8 barrels of oil).

[3] Op cit, p. 24.

FIGURE 2.3

Energy Balance
IEA Region
1973-1990



Geothermal

Currently, geothermal energy accounts for less than 0.1 percent of world energy production. However, worldwide geothermal production will expand from 1400 MWe to 7000 MWe by 1985. The increase from 1400 to 7000 MWe is 1.6 percent to 4.8 percent of the "gap." In addition, direct thermal use of geothermal energy could expand substantially. International activities, such as the CCMS Pilot Study, can assist in increasing the contribution of geothermal energy.

One important aspect of geothermal energy is that it could make a substantial contribution in developing areas such as The Azores, Portugal; Philippines; and Kenya where the problems of energy policy are especially severe.

Solar

The contribution of solar energy to the supply/demand balance is difficult to predict. Note that Figure 2.2 shows no solar contribution. The Pilot Study experts believe that successful demonstration of solar technology is necessary before widespread commercialization can be realized. The Pilot Study has created an international mechanism to inform nations of successful solar applications. In addition, the Pilot Study has established two projects which fostered cooperation and interchange in regional applications of solar heating and cooling and increased national and international awareness of successful demonstrations. These are the "Zero Energy House" and the "Mediterranean Applications" working groups.

The contribtuions of these efforts could be significant. The IEA observes,

> "In most countries, solar heating . . . /is/ considered to have potential to contribute only marginally to the energy balance through 1990. . . A more vigorous effort for more rapid introduction . . . should be undertaken."[4]

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[4] Op cit, p.33.

Rational Use of Energy (Conservation)

This Pilot Study was organized with four subprojects which focused on four different elements of energy conservation in the public, private and industrial sectors. The four subprojects are described below.

1. Industrial International Data Base

This subproject developed a detailed methodology for analyzing the energy consumption of a given industry. This methodology may be used, for example, to pinpoint opportunities for technology transfer from one industry to another or from one country to another for the same industry. The methodology was applied to four industries (cement, steel, brewing, plastics). The results indicated that a savings of 8 percent to 15 percent of total energy demand could be achieved in the short term by implementing appropriate energy saving procedures in industry. Assuming that most (75 percent) of these savings have been included in the IEA Energy Balance, an additional annual savings of 2 percent to 4 percent of total energy could be realized by employing these procedures. For 1985, this would be a savings equivalent to 90 to 180 million tonnes of oil or 15 to 90 percent of the "gap." Of course, realization of these savings depends on many economic, technical, environmental and institutional factors which vary among nations.

This conclusion is supported by the IEA which states,

> "the industry sector is the largest and fastest growing consumer of energy . . . On present projections it also seems to have substantial potential for energy (specifically oil) savings over the next decade. Despite this potential, this sector unfortunately has received the least amount of government attention in terms of energy conservation measures."[5]

2. Modular Integrated Utility Systems (MIUS)

This subproject found that up to 37 percent of the primary energy used to provide utilities (i.e., electricity, water, etc.) to residences could be saved through the MIUS concept. By 1985, the residential sector is expected to consume the equivalent of 950 million tonnes of oil. Assuming that 75 percent is used for utilities and that 25 percent

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[5] Op cit, p. 33

of residences could utilize MIUS, the savings would be equivalent to 66 million tonnes of oil or 11 percent to 33 percent of the "gap."

3. Electric Utility Load Management

The project identified three areas where electric utilities might achieve substantial improvements in economic performance and in reduction of environmental impacts. These areas are under further study through research and demonstration projects by utilities in participating countries. Results could be that, in the short term, loads will be shifted from low efficiency peaking plants to more efficient plants with slack capacity. In the longer term, a permanent readjustment of plant capacities can be made to achieve a new allocation of plants with improved efficiency.

4. Climatic Conditions - Test Reference Year

This project developed a methodology for studying the efficiency of energy systems in buildings relative to climatic conditions. Further research is continuing in this area.

Automotive Propulsion Systems

Because of the inability of the Pilot Project to obtain proprietary data related to short and medium term plans (before 1990) of international automobile manufacturers, most of the Pilot Study focused on longer term issues. The Pilot Study has fostered on-going programs which are designed to increase efficiency (e.g., ceramics project) or reduce dependency on petroleum (alternative fuels project).

By 1985, energy consumption in the transport sector is projected to be equivalent to 786 million tonnes of oil, of which only the equivalent of 7 million tonnes (1 percent) is expected to be non-petroleum based energy. Thus, this sector offers large opportunity for oil savings through increased efficiency or fuel substitution. The Pilot Study, along with other national and international efforts, assisted in developing programs to take advantage of this opportunity.

3. SUMMARIES OF THE PILOT STUDIES

The following sections are summaries of the Pilot Studies. A more detailed presentation is available from the publications of the various Pilot Studies which are listed in the appendix to this report.

3.1 GEOTHERMAL PILOT STUDY

Occurrences of geothermal energy are numerous and scattered throughout the world; yet the resource is very little used today. The approximately 1,400 MWe of geothermal energy being produced in eleven countries represents less than 0.1 percent of the earth's total demand for electrical power (Figure 3.1) and is a much smaller percent of the earth's total potential. In addition, the potential for direct (nonelectric) use of geothermal heat in agricultural, industrial and space heating applications has only been partially explored.

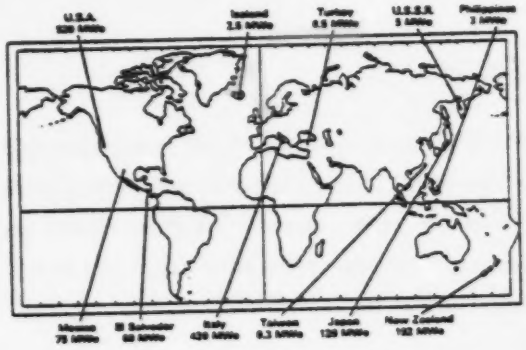

Figure 3.1: Worldwide Distribution Of Geothermal Power

The need for international cooperation to expand geothermal research and development was recognized by the United Nations well before the 1973 oil crisis. As early as 1961, participants at the United Nations Conference on New Sources of Energy made specific recommendations for cooperative research. From 1965 to 1975, the United Nations executed several geothermal exploration projects in cooperation with the governments of El Salvador, Chile, Turkey, Ethiopia, Kenya and Nicaragua. The first United Nations Conference on Geothermal Energy in 1970 further encouraged and supported international geothermal R&D activities. The current status of selected geothermal

developments in the world is summarized in Figure 3.2.

The CCMS Geothermal Pilot Study was begun in 1973 with the United States as Pilot Country and Italy and Turkey as Co-Pilot Countries. The following countries were active participants (Figure 3.3):

Canada
Egypt
El Salvador
Federal Republic of Germany
France
Greece
Haiti
Hungary
Iceland
Indonesia
Ireland
Italy
Kenya
Luxembourg
Mexico
Netherlands
New Zealand
Nicaragua
Philippines
Portugal
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States
Yugoslavia

Experts from twenty-seven nations participated in various parts of the Pilot Study. Geothermal experts from non-NATO countries with a long history of geothermal experience, such as Mexico and New Zealand, played important roles in various substudies. Experts from several developing countries, including El Salvador, Kenya and Haiti, also contributed to the study.

The most significant overall result of the Geothermal Pilot Study has been the establishment of an identifiable international community of geothermal experts. Exchange of information among members of this community has assisted in the design and implementation of national and multinational R&D programs. For example, the U.S. budget for hot dry rock programs was doubled in recognition of the worldwide interest in this technology—an interest enhanced by CCMS. Also, scientists from the Federal Republic of Germany are concentrating their geothermal efforts on possible economic uses for hot dry rock, partially in response to results of the CCMS Pilot Study.

FIGURE 3.2

Status of Selected Geothermal Programs Throughout the World
(For Illustrative Purposes; Not Comprehensive)

Country	Available Resources	Research and Development and Preliminary Exploration	Exploration Drilling	Electricity Production	Direct Heat Applications
Canada	Unknown potential B.C., Yukon, Prairie Provinces	Begun in 1975	Meager Mountain Range		Domestic water and swimming pools
El Salvador	Ahuachapan; San Vincente and Usulutan Provinces		- U.N. in early 1970's - $35 million planned 1976-1980 - Drilling in San Vincente and Usulutan Provinces	- 60 MWe at Ahuachapan - 35 MWe planned for 1979	
France	Limited to Paris Basin; Guadeloupe; Martinique	- Inventory - Geophysical R&D on Hot Dry Rock - Rock permeability studies	2000 exploratory wells in Paris Basin, 1950-1965	Guadeloupe power plant being designed.	Space heating in four regions around Paris
Federal Republic of Germany	Poor hydrothermal resources. Some in Upper Rhine and southwest of Stuttgart.	- Inventory - Deep drilling and rotary high speed drilling - Emphasis on Hot Dry Rock development - Binary cycles	Drilling in 3 regions		
Greece	Limited potential in six areas.	Surveys	3 wells in Milos	Being evaluated	
Iceland	Large resources. Development in southwest corner and north-central.	Very active	Many wells	3 MWe, 55 MWe plant complete with 15 MWe operational	61 percent of population use for domestic heating; other uses underway as pilots
Indonesia	Considerable resources along volcanic belt of the islands. Most exploration on Java and Bali.	Inventory and survey by expatriots	Some on West Java	30 MWe being considered for West Java	
Italy	All fields are on pre-Apennine Belt from Pisa to Naples. Larderello is oldest developed field in the world.	- Extensive SUS 16.9 in 1977. - Experimenting with hydrofracturing	- Extensive - Over 400 wells at Larderello alone	420 MWe, 40 MWe additional planned	In private sector. District heating in Padua and Larderello, Greenhouses
Japan	Plentiful resources	Resource assessment	Several locations on Honshu and Kyusha	128 MWe	Extensive; especially mineral baths
Mexico	Development centered in Cerro Prieto and northwest of Mexico City.	- Begun in 1960 - US-Mexico cooperative investigation at Cerro Prieto	- 40+ wells at Cerro Prieto - Drilling elsewhere	75 MWe being expanded to 150 MWe	
New Zealand	- Wairakei operative in 1958. - Broadlands; Kawerau and Rotorua fields under development.	SUS 6.9 million in 1979 planned		- 202 MWe at Wairakei - 100 MWe planned at Broadlands	- pulp and paper and domestic uses - District heating being evaluated for Auckland
Nicaragua	Momotombo (60 km west of Managua) and Tipitapa	$12 million at Momotombo	19 wells	up to 30 MWe planned	Mineral baths
Philippines	Leyte; southwestern Luzon (Tiwi); Los Banos; Negros Island	Small power plant on Leyte	Leyte 21 wells on Tiwi same at Los Banos	5.5 MWe up to 167 more planned	Saltmaking and grain drying
Portugal (The Azores)	Sao Miguel	Small power plant; Survey	Begun in 1978	3 MWe planned	Being evaluated
Sweden	None identified	$1.6 million 1976-1979 focus on Hot Dry Rock	Oil and gas-associated hot water discovered		
Switzerland	Molasse Basin	Survey			
Taiwan	Estimated in excess of 1000 MWe	Resource assessment	West Coast	0.3 MWe	
Turkey	Under evaluation	Survey and electricity production	Several	.5 MWe; 5 MWe under construction	Greenhouses
United Kingdom	Not promising. Some in southwest and western England and in Scotland.	$1.5 million in 3 years			Possible in Hampshire
USA	Mostly in West	$130 million in fiscal 1978	Many. Especially in California	520 MWe at the Geysers 400 MWe under construction	- District heating - Other uses
USSR	Mostly hot water; steam in Far East	Well stimulation with explosives		5 MWe	Extensive; space heating and greenhouse

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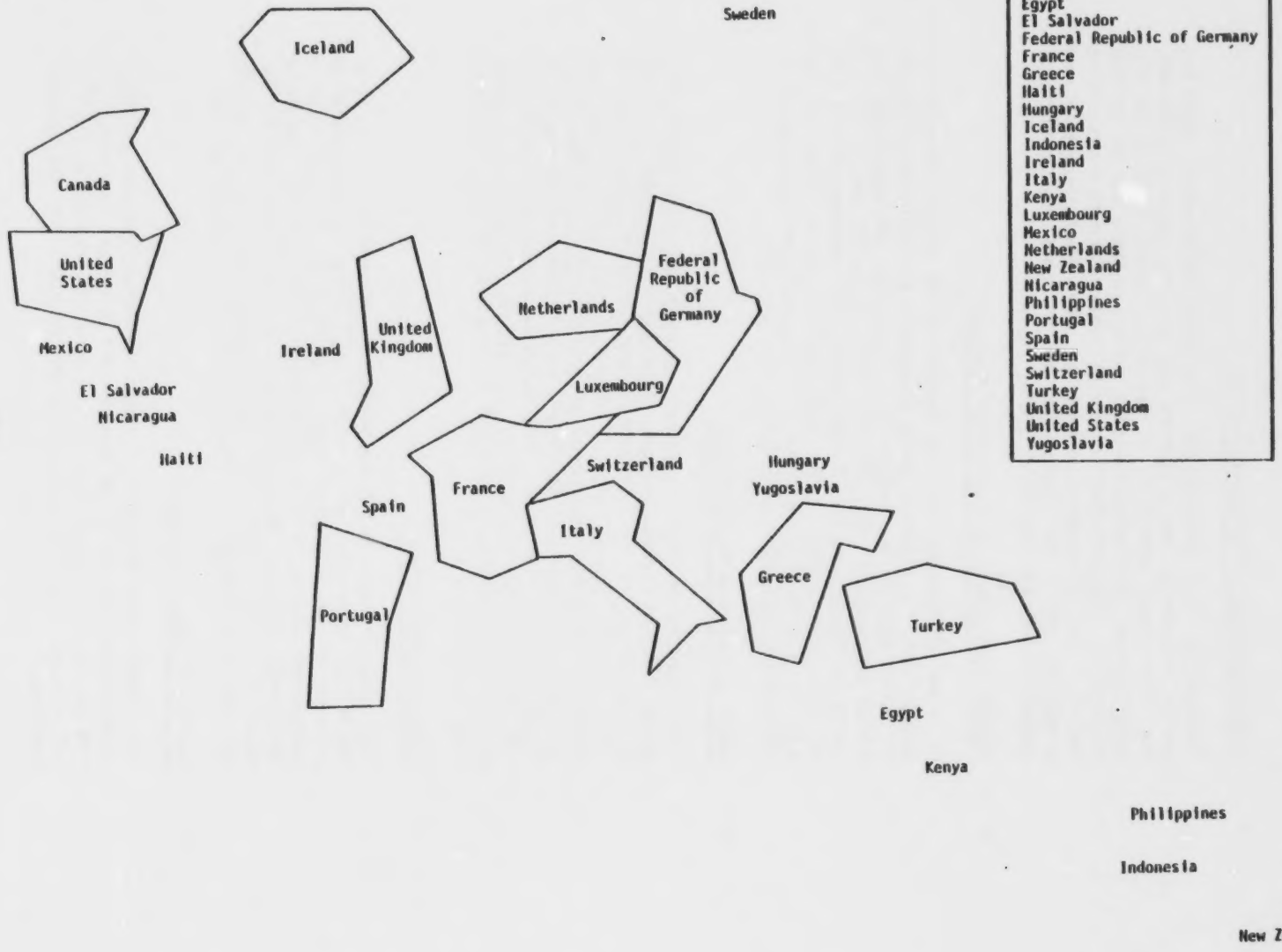
FIGURE 3.3


GEOTHERMAL PILOT STUDY
Canada
Egypt
El Salvador
Federal Republic of Germany
France
Greece
Haiti
Hungary
Iceland
Indonesia
Ireland
Italy
Kenya
Luxembourg
Mexico
Netherlands
New Zealand
Nicaragua
Philippines
Portugal
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States
Yugoslavia
Iceland
Sweden
Canada
United States
Mexico
El Salvador
Nicaragua
Haiti
Ireland
United Kingdom
Netherlands
Federal Republic of Germany
Luxembourg
France
Switzerland
Spain
Portugal
Italy
Hungary
Yugoslavia
Greece
Turkey
Egypt
Kenya
Philippines
Indonesia
New Zealand

The Pilot Study focused on five areas as follows:

- Computer-Based Information System

  Recognizing that increasingly voluminous information regarding geothermal energy would become available as research continued, the Pilot Study conducted a one-year feasibility study of the establishment of a computer-based system to store and access this information. This included the development of formats for reporting technical and bibliographic information. As a result, the system was established and is now operational and available under a bilateral agreement between the United States and Italy.

- Direct Application of Geothermal Energy

  In order to demonstrate the feasibility of direct (nonelectric) applications, the substudy group prepared a state-of-the-art report on direct applications worldwide. The group also sponsored two workshops on direct applications. The results focused on the key issues for developing direct applications and recommended future specific national and multinational R&D programs. Work in this substudy also heightened interest in "cascading energy systems" or "total energy recovery" or "cogeneration" concepts.

- Small Geothermal Power Plants

  This substudy reviewed a system concept for small geothermal power plants at two conferences. Subsequently, technical guidelines were prepared for the procurement and construction of a small (5 MWe) portable power plant. Several small power plants are operational or under construction at least partially due to the results of this study. These include one at Leyte, Philippines and one at Sao Miguel, Azores, Portugal. This substudy increased international interest in advanced generation concepts such as the helical screw expander. International research in this area is being continued under the auspices of IEA.

- Reservoir Assessment

  This substudy sponsored three workshops and several site visits on reinjection technology as a method of solving the environmental problem of brine disposal and of prolonging the quality of a geothermal reserve. This substudy provided the basis for a bilateral agreement between Mexico and the United States for further research. The results of this substudy resulted in general acceptance of reinjection as the preferred brine disposal method.

- Hot Dry Rocks Concepts

  This substudy was designed to broaden the knowledge and experience of scientists involved in the development of hot dry rock energy. It was carried out through the visiting scientist program at the U.S. Los Alamos Scientific Laboratory and through two international meetings.

The pilot study will conduct a follow-up conference in 1980 to review the progress of geothermal development. In addition, the Pilot Study has submitted recommendations for the following:

1. Continuation of the U.S.-Italy bilateral agreement for the information systems. Both nations are encouraging use of the systems by other nations. In fact, many other nations are already participating.

2. Continuation of the U.S.-Mexico bilateral agreement regarding reservoir studies, brine disposal and many other issues. This project is open to participation by other nations.

3. Continuation of multinational information exchange regarding small scale geothermal power plants including the helical screw concept.

4. Adoption of international programs in hot dry rock technology through an international organization. The IEA has one project in this area underway.

3.2 SOLAR ENERGY PILOT STUDY

The Solar Energy Pilot Study began in 1973. The United States served as Pilot Country and Denmark and France as Co-Pilot Countries. The participating countries are shown in Figure 3.4. These countries are:

Australia
Belguim
Brazil
Canada
Denmark
France
Federal Republic of Germany
Greece
Iran
Israel
Italy
Jamaica
Luxembourg
Monaco
Netherlands
New Zealand
Portugal
Saudi Arabia
Spain
Sweden
Turkey
United Kingdom
United States

The European Commission participated as an unofficial member.

The Pilot Study focused on solar heating and cooling applications in buildings. One of the most significant accomplishments of the Solar Pilot Study was to provide a forum for interchange of technical and programatic information which influenced the development and acceleration of solar heating and cooling programs at the national level. Whereas, at the beginning of the study, only four countries had a formal solar energy R&D program, by 1978, 13 of the 15 participants in the information exchange program had a formal program (Figure 3.5). The growth in national solar energy programs from 1973 to present is shown in Figure 3.5.

The Pilot Study found that solar technology has advanced to the point that people are now looking for evidence of successful performance (both technical and economic) of projects. Once success is proven, wide-scale commercial application will follow.

FIGURE 3.4

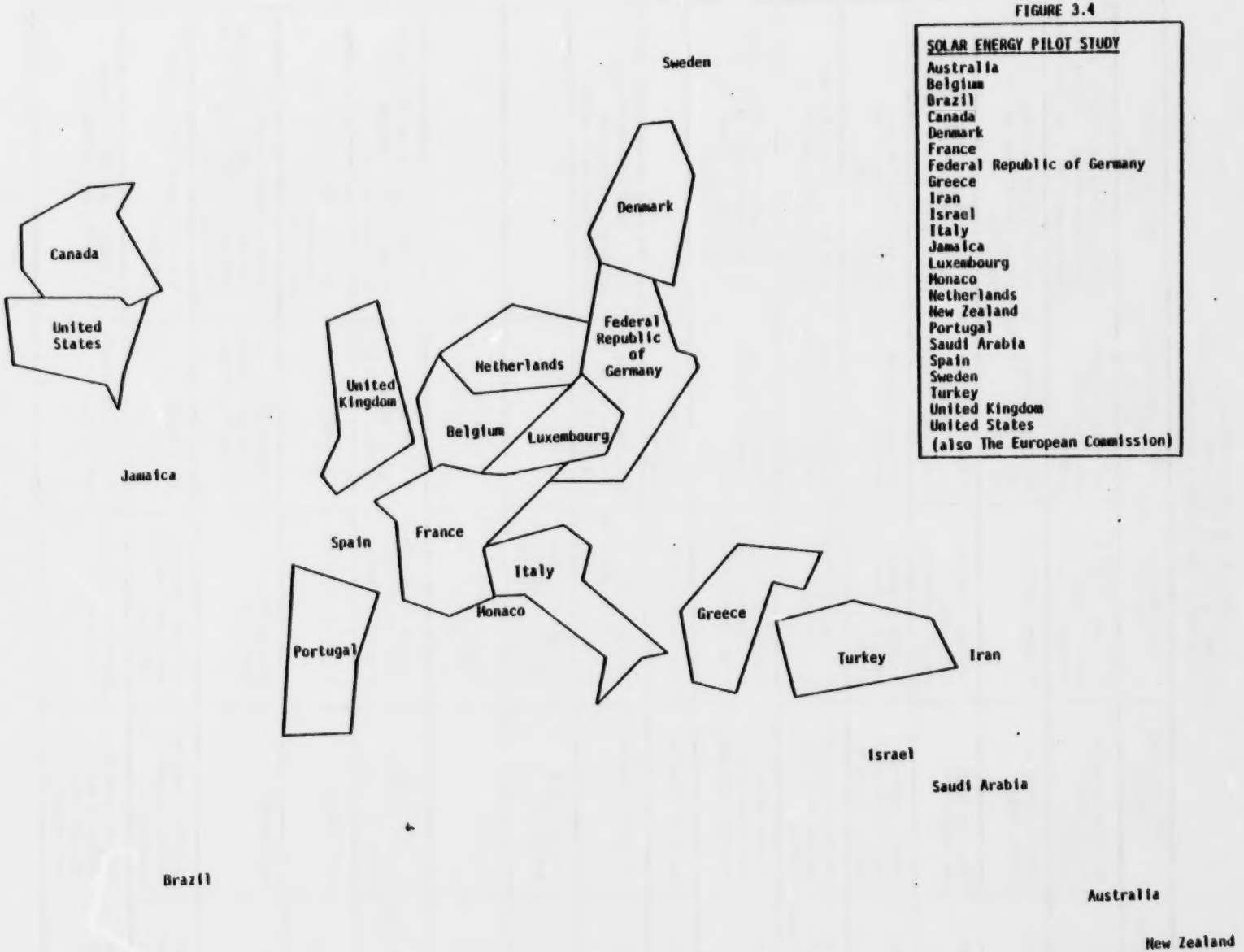

SOLAR ENERGY PILOT STUDY
Australia
Belgium
Brazil
Canada
Denmark
France
Federal Republic of Germany
Greece
Iran
Israel
Italy
Jamaica
Luxembourg
Monaco
Netherlands
New Zealand
Portugal
Saudi Arabia
Spain
Sweden
Turkey
United Kingdom
United States
(also The European Commission)
Sweden
Canada
Denmark
United States
United Kingdom
Netherlands
Federal Republic of Germany
Belgium
Luxembourg
Jamaica
France
Spain
Italy
Monaco
Portugal
Greece
Turkey
Iran
Israel
Saudi Arabia
Brazil
Australia
New Zealand

FIGURE 3.5

Summary Of The Status Of The
Solar Heating And Cooling Systems In Buildings
Programs Of The Signatory Countries

COUNTRY	1974 (Odeillo) STATUS	1975 (Palo Alto) STATUS	1976 (Copenhagen) STATUS	1978 (Dusseldorf) STATUS
Australia	No formal program - many projects underway.	No formal program - many projects underway.	No formal program - many projects underway.	RD&D supported by national and state governments. National program expected to be developed.
Belgium	Program being formulated.	Program initiated.	Program underway and several projects initiated.	Initial 3-year nationally funded R&D program nearing completion.
Canada	Need for solar not established.	Program initiated and several projects started.	Program underway with increased funds and projects.	R&D program continues with 8-fold increase in funding since 1976.
Denmark	Program underway involving several several projects.	Program underway involving several projects.	Expanded program underway.	Increased funding and additional projects in national program.
Federal Republic of Germany	Program initiated - several projects underway.	Program significantly expanded.	Program continues to expand significantly.	Large scale program for R&D and government support of industry.
France	Program being formulated-several projects underway.	Program initiated and projects significantly expanded.	Program continues to expand significantly.	Solar Energy Agency established to coordinate large national program and government and private projects.
Greece	No formal program.	Program initiated.	Limited program underway.	
Israel	No formal program.	Program initiated and several projects started.	Program underway with initiation of new projects.	Program continues government supported research by universities and industry.
Italy	Program being formulated.	Program initiated - several industrial projects underway.	Not present.	
Jamaica	Observer.	Program being formulated.	Not present. Limited program initiated.	
The Netherlands	No formal program- Several projects being initiated.	Program being formulated - additional projects underway.	Program being formulated - projects continuing	Expanded funding and RD&D activities. Formal program to be initiated shortly.
New Zealand	Not present.	No formal program.	Not present.	No formal program, but government support of R&D activities.
Spain	Not present.	Program being formulated.	Program being formulated - several projects underway.	National coordination of funding and expanded activities underway. Formal program to be initiated in 1979.
United Kingdom	No formal program - several projects underway.	No formal program - additional projects initiated.	Not present.	Four year government program underway.
United States	Program underway involving many R&D and demonstration projects.	Significant growth in program.	Significant growth continues.	Further expansion of large, multi-faceted program.

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3.2.2 Accomplishments

The accomplishments of the Pilot Study are listed below.

- Review of National Solar Heating and Cooling Programs

  At four annual meetings of the Pilot Study, status reports were presented by each country. Program managers and technical experts were able to review their programs in the context of others and to note opportunities for improvement of their national program and for closer international cooperation.

- Information Exchange

  Experts in the Pilot Study felt that reliable, believable performance data from demonstration projects is essential for the development and widespread adoption of cost-effective solar heating and cooling systems. Thus, the Pilot Study developed the "System Performance Reporting Format" for solar heating and cooling systems. The format was then used as a guide for writers preparing reports on system performance. Such reports were distributed via the Pilot Study information dissemination system. This CCMS Format has been used as the basis for development of performance reporting guidelines within France, Sweden, and the United States, among others. The IEA is now in the process of developing, in collaboration with the CCMS participants, a new version of the format.

  In addition to the system performance reports, the Pilot Study participants exchanged seventy solar heating and cooling reports originating in eleven countries. As part of the information exchange system, the Pilot Study participants identified and used both a national contact person and an information source (e.g., a national technical library).

  The Pilot Study initiated a memorandum-of-understanding which provides for the systematic exchange of technical reports among signatory nations.

- International Conference

  The Pilot Study and the Federal Republic of Germany section of the International Solar Energy Society (ISES) jointly sponsored an International Conference on the Performance of Solar Heating and Cooling Systems. It was attended by over 200 government officials and technical experts. The conference proceedings containing all sixteen performance reports, written in accordance with the CCMS Format, will allow a large audience access to the performance data on actual operating systems.

- Zero Energy House Group

  Under the chairmanship of Denmark, this group was formed in 1974 to exchange information regarding solar-assisted, low-energy dwellings for northern European climatic conditions. The seven participating countries have agreed that the exchange was very valuable and that it should continue. The informal discussion and exchange of information on innovative design and engineering concepts was considered especially effective.

- Mediterranean Application Group

  This ten-country group, chaired by France, has focused on the application of passive heating and cooling systems (i.e., building design, natural ventilation, etc.) in Mediterranean climates. This group will continue its cooperative efforts during the two-year CCMS follow-up period.

3.2.2 General Recommendations

1. International cooperation in the field of solar heating and cooling technology development should continue.

2. Nations should strive to develop common international test procedures, definitions and standards for solar heating and cooling components and systems.

3. Small, informal, international expert groups can effectively deal with particular issues (e.g., the "Zero Energy House" or the "Mediterranean Study"); such groups should continue.

4. Increased exchange of information on solar technology should be emphasized. This allows informal discussions on the results of R&D projects.

5. Exchange of information on national solar R&D strategies and priorities should continue.

3.2.3 Specific Recommendations

1. Systems Performance Reporting Format

   The Pilot Study recommends further modification of the CCMS reporting format continue under the auspices of the IEA, with the collaboration of the Pilot Study participants.

II. Zero Energy House Group

The Pilot Study recommends transferring this project to IEA while calling for annual reports on the Group's activities and an open technical conference.

III. Mediterranean Application Group

The Pilot Study recommends this project continue under CCMS auspices during the follow-up period. If an acceptable international organization can be found, the project should be transferred there.

IV. Review of National Solar Heating and Cooling Programs

The Pilot Study recommends that this project continue during the follow-up period while transfer to the International Solar Energy Society is explored.

V. Memorandum of Understanding

The Pilot Study recommends that this continue in effect during the follow-up period.

The Pilot Study has also formulated a number of technical and programmatic recommendations for national action. In addition, the Pilot Study has prepared a resolution calling for continued cooperation among nations in the development of solar heating and cooling technology.

3.3 RATIONAL USE OF ENERGY (RUE)

The Rational Use of Energy Pilot Study focused on energy conservation and the improved management of energy use. Energy is essential to virtually every aspect of human activity—in government, industry or the home. In order to keep its effort manageable, the RUE Pilot Study focused on particular energy uses in which the participants shared a common interest. The study addressed the technical issues which could be implemented in the short to medium term (up to 10 years) using existing technology.

The substudies are:

- The Industrial International Data Base Project.
- The Modular Integrated Utilities System (MIUS) Project.
- Climatic Conditions and Test Reference Year Project.
- Electric Utility Load Management

Accomplishments

In general, the Pilot Study accomplished the following:

- Beginning of the process of understanding the potential for energy conservation.
- A mutual sharing of data and experience.
- A substantial influence in establishing national conservation goals and programs.
- The establishment of direct contacts among industry officials from different countries to exchange technical information on energy conservation.

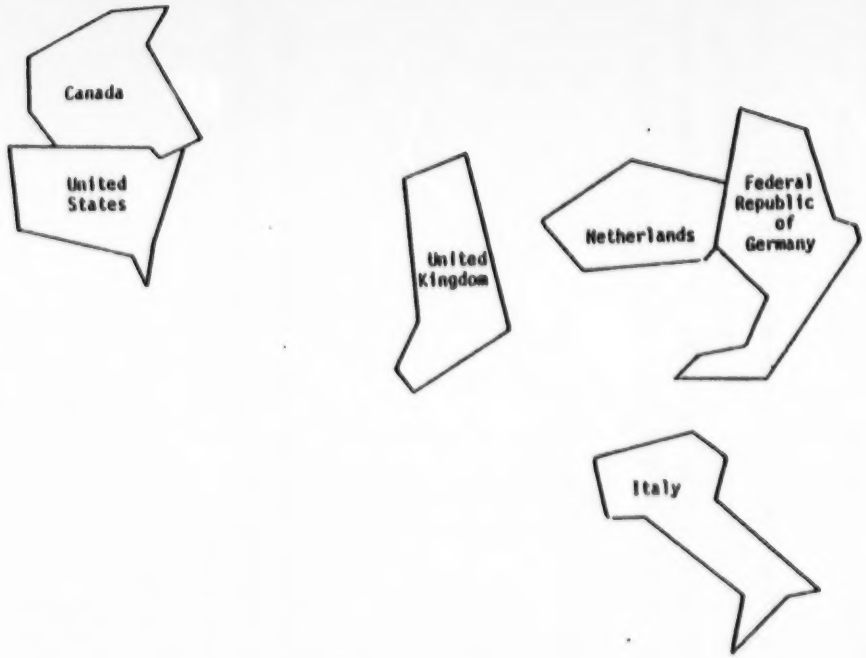
3.3.1 Industrial International Data Base

Participants in this subproject are shown in Figure 3.6. They are:

FIGURE 3.6

INDUSTRIAL INTERNATIONAL DATA BASE

Canada
Federal Republic of Germany
Italy
Netherlands
United Kingdom
United States
(also the NATO Secretariat)



Canada	Netherlands
Federal Republic of Germany	United Kingdom
Italy	United States

The NATO Secretariat and several other nations also provided assistance.

The basic objectives of the Data Base Project were:

1. To collect data, in comparable format and for corresponding manufacturing systems, on industrial energy consumption for specific industries.

2. To identify and analyze any significant difference in energy use between nations for corresponding industries and, thereby, develop information on energy-conservation technology and operating practices already in effect in some nations which could be adopted in others in the short to medium term.

3. To develop recommendations for plant demonstrations and for R&D of energy-efficient technology in major industrial sectors.

In order to achieve the objectives, it was necessary to develop a methodology for collecting and analyzing the information. The report on this methodology, "Guidebook for Energy Analysis," serves as a guide for future efforts to measure industrial energy consumption. The United Nations Environmental Program has adopted this methodology.

Information was collected on the following industries:

- Cement
- Steel
- Brewing
- Plastics

The basic energy consumption data for these industries was assembled with the participation of several countries. This was the first comprehensive assembly of such data on strictly comparable bases.

These studies draw attention to the fact that there is a strong relationship between energy consumption and the consumption of other natural resources. The studies show that there is a substantial "energy content" in industrially produced materials.

These studies have stimulated direct adoption of energy conservaion techniques. For example, the U.S. cement industry has shown great interest in the results of the pilot study. The studies have also produced R&D programs to achieve further efficiency. As a result of the Pilot Study, a cooperative R&D program for cement has been initiated under the auspices of the IEA by the United States, the United Kingdom, the Federal Republic of Germany, and Sweden. A similar program for the steel industry is currently being developed by the IEA.

Recommendations

Technical recommendations for each of the industries studied are presented in the reports of the Pilot Study (see Appendix). The following are the general recommendations of the Study.

1. Energy Pricing

   Realistic energy pricing policies should be adopted for all primary fuels in each nation, having due regard to national needs and the overall objective of resource conservation.

2. Electricity Pricing

   Electricity pricing structures which encourage conservation by the consumer should be developed.

3. Integration of Environmental and Energy Policies

   Environmental policies and energy policies should be integrated at all stages from formulation to implementation.

4. Systems Approach

   A systems approach to analyzing energy and materials substitution possibilities should be adopted in all policy development, the envelope to be drawn around the system boundary being the key element in the analysis.

5. Fuel Substitution

Efforts should be made in each nation to document fuel substitution possibilities relative to current energy consumption patterns, establishing data on technical feasibility, time to convert, and the economic factors involved for all energy consuming sectors.

6. Recycling of Materials

Recycling of materials for re-use should be thoroughly investigated and, where found appropriate, should be encouraged by whatever means appropriate to the local situation. Recycling may frequently prove to be a means of achieving short term energy savings of significant magnitude.

7. Incentives for Energy Conservation

Incentives for energy conservation by companies and by individuals should be considered in all nations. Those incentives should apply to conservation through better management of resource use, as well as through capital investment in improved plant and buildings.

8. Government Construction as Examples

Through government agencies responsible for large-scale construction projects, an example should be set to the private sector in the use of appropriate materials specifications and standards of building design and operation.

9. Construction Specifications Based on Performance

In particular, government agencies should be given the responsibility of insisting on specifications based on performance, wherever this is appropriate in regard to energy factors.

10. Free Interchange of Information

A free interchange of information relating to energy consumption and conservation in all sectors should be encouraged. This applies to information flows within sectors, across sectors and among nations in general.

11. Encourage International Technology Transfer

Nations should make efforts to encourage technology transfer and not raise tariff or other barriers to licensing procedures.

12. Foster the "Energy Conservation Ethic"

The "energy conservation ethic" should be fostered through education, with special emphasis on comprehensive programs designed for school-age children.

13. Data on Industrial Energy Consumption

Nations should establish reporting mechanisms for registering the energy consumption of major segments of industry by quantity and type of energy resource consumed.

14. Company Level Conservation Goals Based On Energy Audits

Individual companies should be encouraged to audit plant operations, to document clearly energy consumption data and to establish energy conservation potentials and voluntary goals.

15. Monitor Company Performance

Regular monitoring of companies' energy consumption should be performed to measure progress against goals.

16. Adopt Electricity Load Management Techniques

Policies to improve the efficiency of electricity generation and distribution through load management techniques should be encouraged. These policies should be directed both to utility companies and to ultimate consumers.

17. Encourage New Investment in Energy Efficient Technology

Governments should study methods appropriate to local conditions to encourage new investment in energy efficient technology, applying to new plant investment and to retrofitting technology in existing plants.

18. Support R&D

Energy-related R&D should be strongly supported; this will cover a broad range of topics, including work on manufacturing processes, materials applications, recycling, etc.

19. Recognize Importance of Conservation Versus New Energy Supplies

The energy and environmental benefits of conservation vis-a-vis development of new supplies should be recognized, and appropriate support given to conservation-related R&D.

3.3.2 Modular Integrated Utility Systems (MIUS)

The Modular Integrated Utility System Concept brings together sub-systems that together provide improved means for furnishing essential services for residential communities.

The MIUS "recycles energy" by providing an option to package into one processing plant all of the six utility services necessary for community development—

- Electricity
- Space heating and water heating
- Air conditioning
- Solid waste processing
- Wastewater treatment
- Residential water purification

Conventional methods of generating electricity convert about 35 percent of the energy input to electrical output. The remaining 65 percent is vented to the atmosphere or flowing water in a manner that optimizes the electrical conversion process. MIUS theoretically can recover better than half of this rejected energy and use it for space heating, air conditioning, water heating, and to improve wastewater treatment efficiency. An additional 5 - 10 percent fuel savings can be made by recycling solid waste for its energy content.

In addition to saving energy, MIUS minimizes the environmental impact of utility systems.

The CCMS-MIUS Project is led by the United States. Participating counties are shown in Figure 3.7. They are:

Austria
Belgium
Canada
Denmark
Italy
Netherlands
New Zealand
Spain

Federal Republic of Germany
Finland
France
Sweden
United Kingdom
United States

Accomplishments

1. International Meetings

   Five international meetings of the Working Group were held. At these meetings, information was exchanged and personal contacts developed.

2. Glossary of Terms

   In order to facilitate information exchange, a "Glossary of Special Terms Unique to MIUS Type of Projects" was prepared and distributed.

3. International Project Catalog

   The International Project Catalog, a compilation of 209 project descriptions of MIUS type of projects in participating countries, was prepared.

4. Reporting Form

   A Project Progress/Evaluation Report form was designed. It can be useful in the comparison of similar projects. Its future development and use will be referred to future activities of other International organizations.

5. Methodology for Measurement

   A standard methodology for measuring the performance of MIUS type of projects and for reporting and taking of data was developed.

6. Research Needs

   A list of research needs in integrated utility systems was identified for consideration in future studies and projects.

7. "Incentives and Barriers" Analysis

   A draft of the paper on the "Incentives and Barriers" to the implementation of MIUS type of projects was prepared and is being further refined by Pilot Study participants.

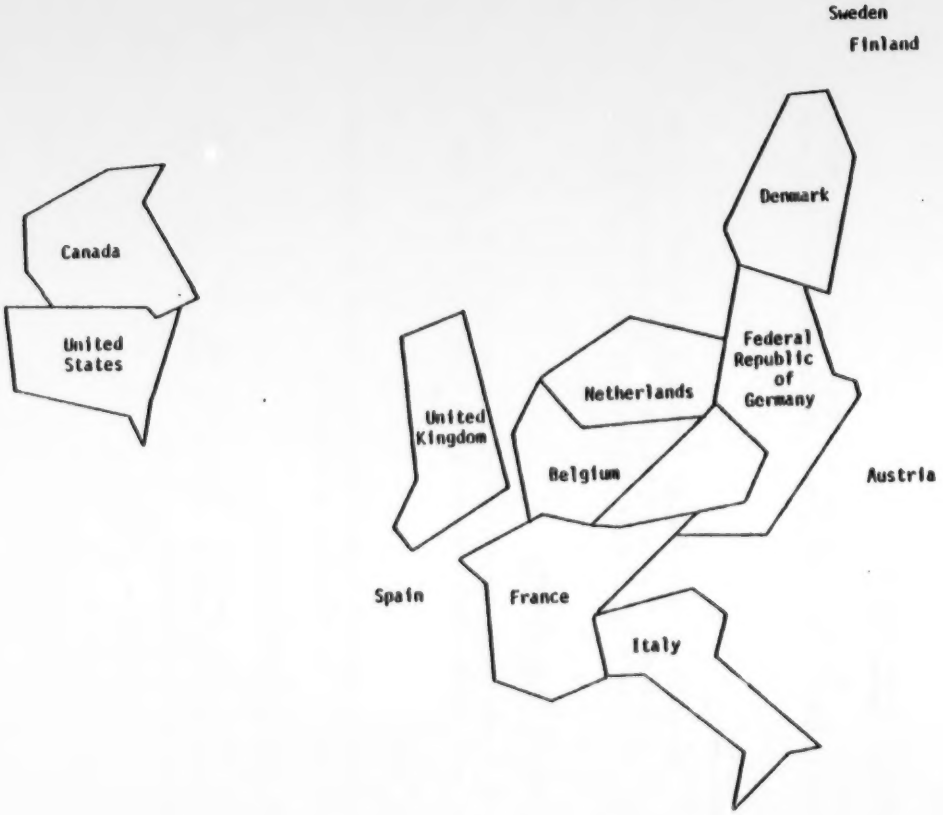


FIGURE 3.7

MODULAR INTEGRATED UTILITY SYSTEMS

Austria
Belgium
Canada
Denmark
Federal Republic of Germany
Finland
France
Italy
Netherlands
New Zealand
Spain
Sweden
United Kingdom
United States

Recommendations

The CCMS-MIUS Project Committee recommended the following:

1. Continuing the information exchange among countries.

2. Continuing the Project Catalog and the exchange of data from these projects, the standard methodology for measuring and reporting the performance of integrated utility systems and the work of the "Incentives and Barriers Committee."

3. Development of a mechanism for informing countries of their need to change laws and regulations to receive the benefits of integrated utility systems.

4. Development of procedures to provide the services of experts to assist countries which request assistance in the implementation of integrated utilities systems.

5. That technical research be carried out in areas specified by the Working Group.

3.3.3 Climatic Conditions and Test Reference Year (TRY)

The objective of the TRY substudy was to present recommendations for weather data collection suitable for energy consumption calculations, especially energy consumption for heating and climatization of buildings, and, if possible, to present recommendations on one or a few methods for producing such data collection.

Participants (Figure 3.8) included:

Belgium	Netherlands
Denmark	Sweden
Federal Republic of Germany	United States

Written contributions were produced by France and Finland.

The TRY substudy included two meetings where information on TRY approaches was exchanged among participants. The result was the design of a study to develop a methodology for producing a TRY.

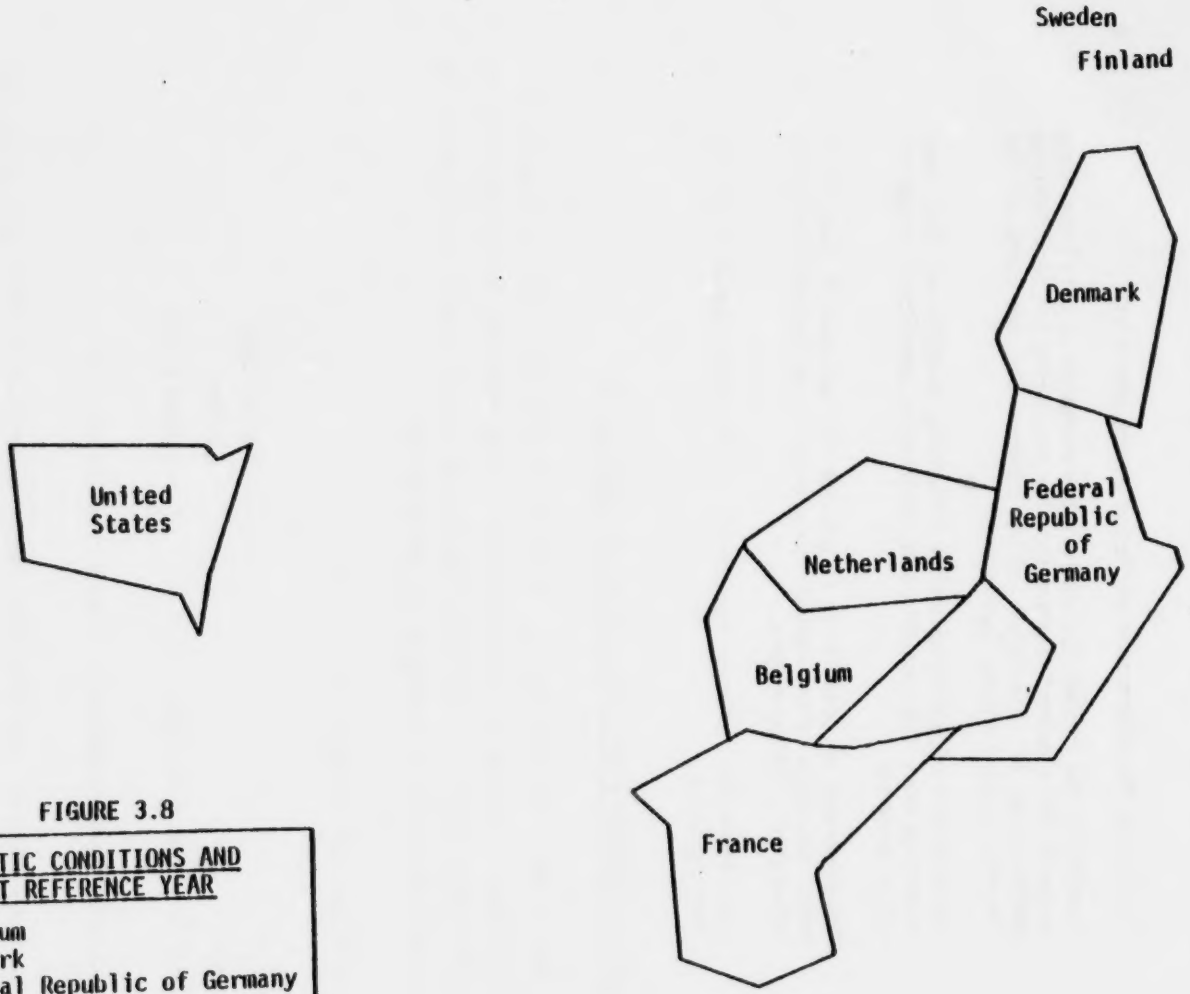


FIGURE 3.8

CLIMATIC CONDITIONS AND TEST REFERENCE YEAR

Belgium
Denmark
Federal Republic of Germany
Finland
France
Netherlands
Sweden
United States

During the study, the need to provide data on solar radiation became apparent. This project was subsequently undertaken by the IEA.

3.3.4 Electric Utility Load Management

The demand for electricity is characterized by daily and seasonal "peaks." The electricity supply system in an industrialized nation is designed to meet these peak demands. As a result, substantial generating capacity is idle (unproductive) during non-peak periods. By reducing the peaks, it is possible to increase the efficiency of the system, reduce unit operating costs, improve the productivity of invested capital, and reduce use of plants with less pollution abatement capability.

CCMS sponsored a series of conferences to provide a forum for representatives of United States and European utilities to exchange views and experiences on the various aspects of load management. Participating countries (Figure 3.9) included:

Belgium
Denmark
Federal Republic of Germany
France
Ireland
Italy
Netherlands
United Kingdom
United States

Observers from industry, as well as government agencies, participated.

In response to the interest expressed by the participants in the CCMS conferences, the United States and several European governments, national electric utility industry organizations, state public utility commissions and many individual utilities have undertaken research and demonstration projects to investigate and test various aspects of load management.

Recommended Areas for Further Research

The consensus of the utility representatives attending the meetings was that three overall approaches offer significant opportunities for achieving improved load management. They are:

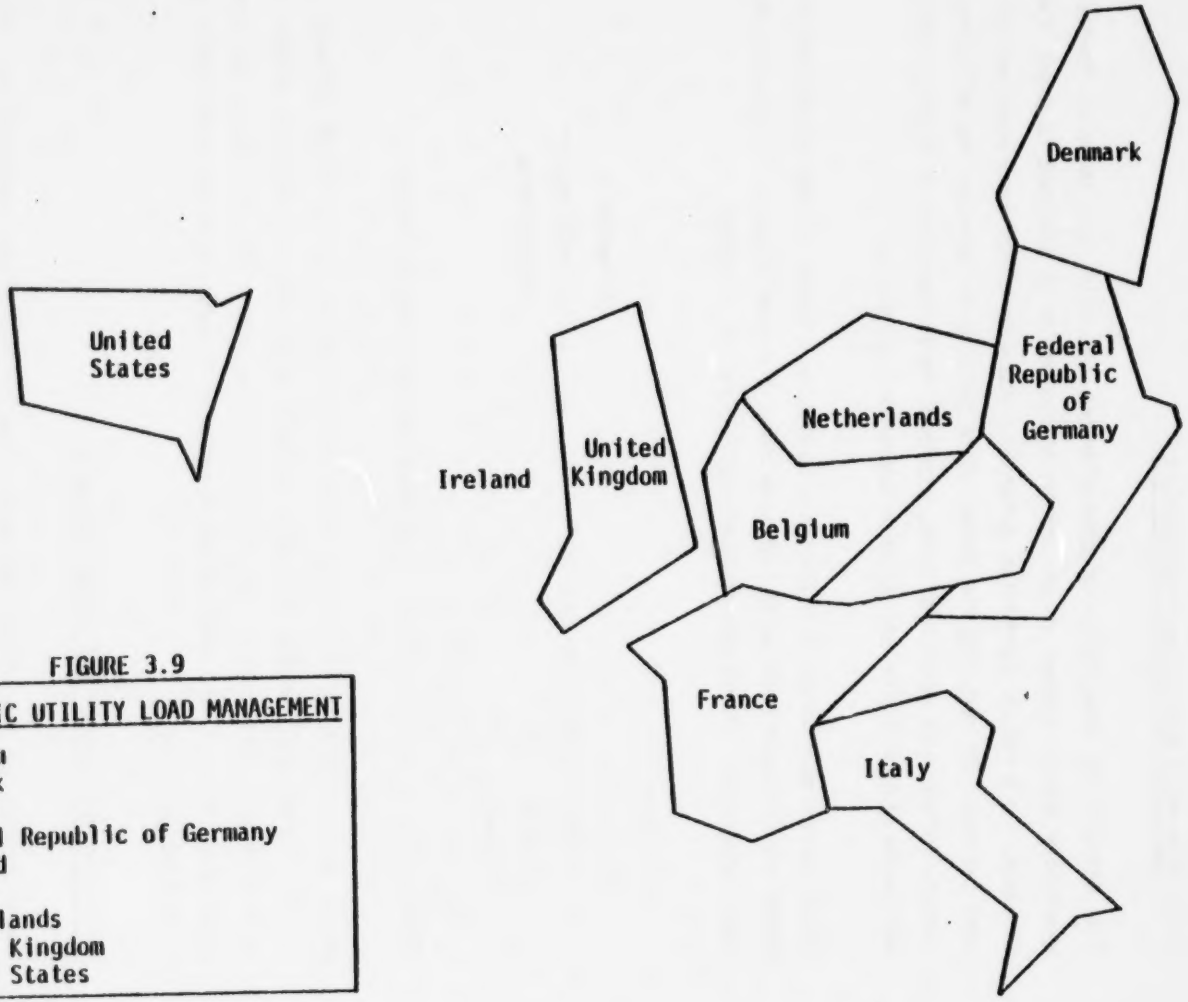


FIGURE 3.9

ELECTRIC UTILITY LOAD MANAGEMENT

Belgium
Denmark
France
Federal Republic of Germany
Ireland
Italy
Netherlands
United Kingdom
United States

- Development of marginal cost rate structures.
- Utilities improving load management through two methods: power pooling and energy storage.
- Actions by consumers to level loads through interruptible power and deferred load control, peak self-generation, and shifts in operating schedules.

3.4 AUTOMOTIVE PROPULSION SYSTEMS (APS)

The worldwide automotive industry was started by a number of individuals—inventors, engineers, and entrepeneurs—who established their businesses largely on the basis of free enterprise, competition, and individual accomplishment. They built large, profitable organizations largely without government support but with varying amounts of interference from government and labor. Most of the research, engineering, and development was done internally and secretly.

In the 1960's, changes began. For example, in the United States, starting with the Clean Air Act of 1967, legal control of automotive emissions began. Stringent requirements significantly influenced the content and direction of the industry's research and development activities. With the oil embargo in 1973, the emphasis now has shifted to increasing the fuel economy and using alternative (nonpetroleum) fuels as legal requirements for fuel economy levels are imposed. In addition, safety regulations are being imposed. All these regulations combined create major technical difficulties. Usually, improved fuel efficiency or increased safety equipment results in increased emissions. Conversely, reduced emissions may result in decreased efficiency. The Automotive Propulsion Systems (APS) Pilot Study evolved against this background of complexities.

The APS Pilot Study began as a part of the CCMS Air Pollution Pilot Study in November, 1970. The study was initially called the "Low Pollution Power Systems Development" (LPPSD) study. This study was oriented toward resolving issues associated with the emissions requirements for automobiles. The goals for the LPPSD program were:

- Information exchange directly among experts.
- Conduct technical symposia.
- Conduct collaborative projects.

The OPEC oil embargo of 1973, and the resultant reassessment of the availability of petroleum for the long-term operation of transportation systems, created concern that shortages of petroleum may occur as early as 1985. Thus, when the Air Pollution Pilot Study was completed in 1974, the LPPSD program was converted to the Automotive Propulsion Systems (APS) Pilot Study. The goals of the APS are:

- Energy conservation.
- Energy conversion efficiency improvements.
- Use of alternative (nonpetroleum-based) fuels including emphasis on wide use of electric and hybrid vehicle systems.
- Safety
- Reduction of automotive noise, especially in urban areas.
- Low exhaust emissions.

APS considered all highway vehicle systems including automobiles, trucks, and buses.

Nations officially participating in the APS Pilot Study are shown in Figure 3.10. They are:

France
Federal Republic of Germany
Italy
Netherlands
United Kingdom
United States

Canada and Sweden participated as observers.

The Pilot Study found that collaborative R&D programs including joint funding and research offered potential advantages to participants. However, development of such programs proved very difficult due to the conflicts created by multilateral patent regulations and the necessity to protect proprietary information.

3.4.1 Accomplishments

1. Symposia

The major accomplishment of the APS Pilot Study was the conduct of the international sympasia as described below.

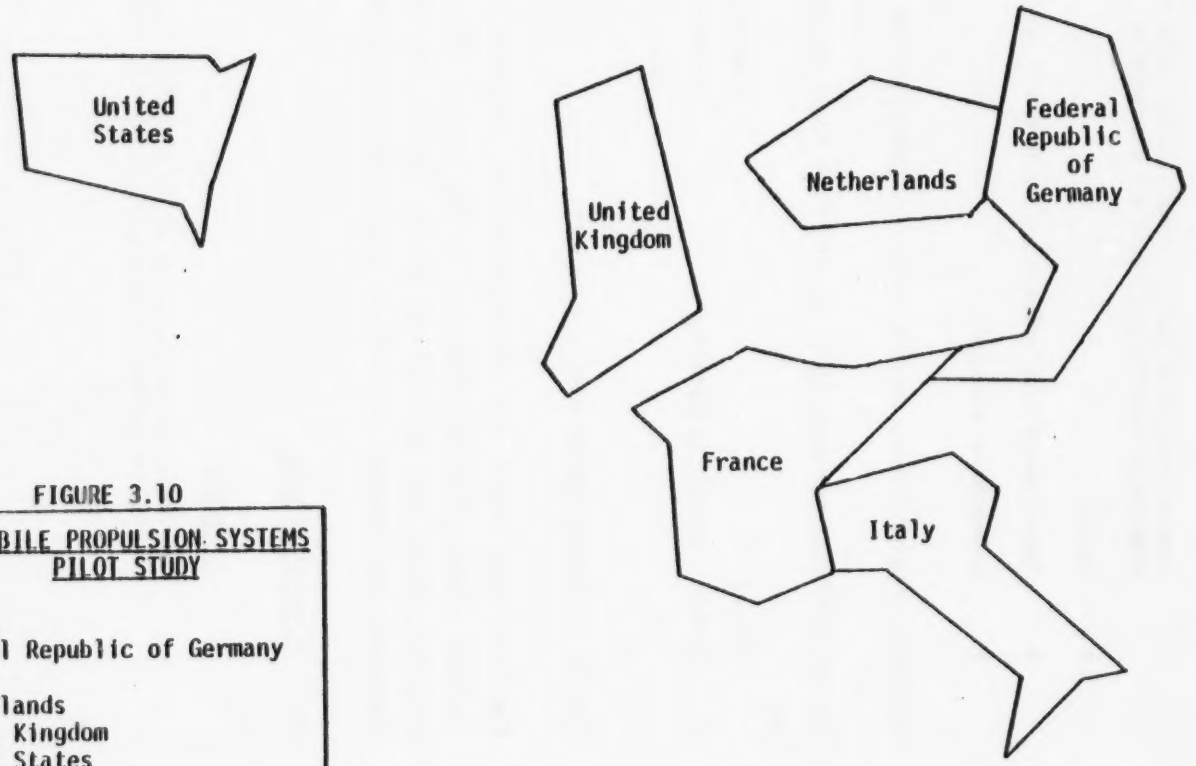


FIGURE 3.10

AUTOMOBILE PROPULSION SYSTEMS PILOT STUDY

France
Federal Republic of Germany
Italy
Netherlands
United Kingdom
United States

APS International Symposia

DATE	LOCATION	SPONSORING ORGANIZATION	APPROXIMATE ATTENDANCE
1973	U.S.A.	U.S. Environmental Protection Agency	340
1974	Federal Republic of Germany	Ministry of Interior and Ministry of Research and Technology	+500
1975	Italy	Italian Ministry of Transport	Limited to Government Representatives
1977	U.S.A.	U.S. Energy Research and Development Administration	500

Attendees at these symposia included technical and management oriented people from governments, industry, and academia in all of the participating and observing countries. Specific private and government-sponsored programs were reviewed and discussed in an open and candid manner. Technical summary reports were issued for each symposium. Each symposium included an exhibit of selected vehicles, components, and models to illustrate the programs being reviewed in the technical presentations.

Main themes or lines of development which showed continuity through the symposia were:

- Advanced Heat Engines
  - Stirling Engine
  - Gas Turbine
  - Rankine Engines
  - Rotary Engines
- Conventional Engines
  - Improved Spark Ignition Engines
  - Stratified Charge Engines
  - Diesel Engines

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- Transmissions/Powertrain Components
- Accessory Drives
- Alternative Fuels
- Electric and Hybrid Systems
- Technology Support Programs
- Technology Assessment, Coordination, Systems and Concept Studies

At these symposia, informal discussions focused on common technical problems. The symposia provided a quick, comprehensive review of the specific problem areas, the status of progress toward their solution, and good perspective of the trends in development. They also provided an opportunity to identify critical areas which may not have been receiving sufficient attention and areas where cooperative programs would be appropriate to reduce cost or accelerate progress.

2. Reporting on National APS R&D

As Pilot Country, the United States developed a system for reporting APS programs within each participating country in a common format. These reports provided another means of information exchange internationally. Results of the 1975 reports are shown in Figure 3.11.

3. Identification of Industry and Government Contacts

Because of the autonomy of the automobile industry in most countries, the working group experienced difficulty in identifying the appropriate industrial officials for receiving (and providing) technical information from participating countries. As the result of considerable effort, these officials have been identified and technical contacts have been facilitated.

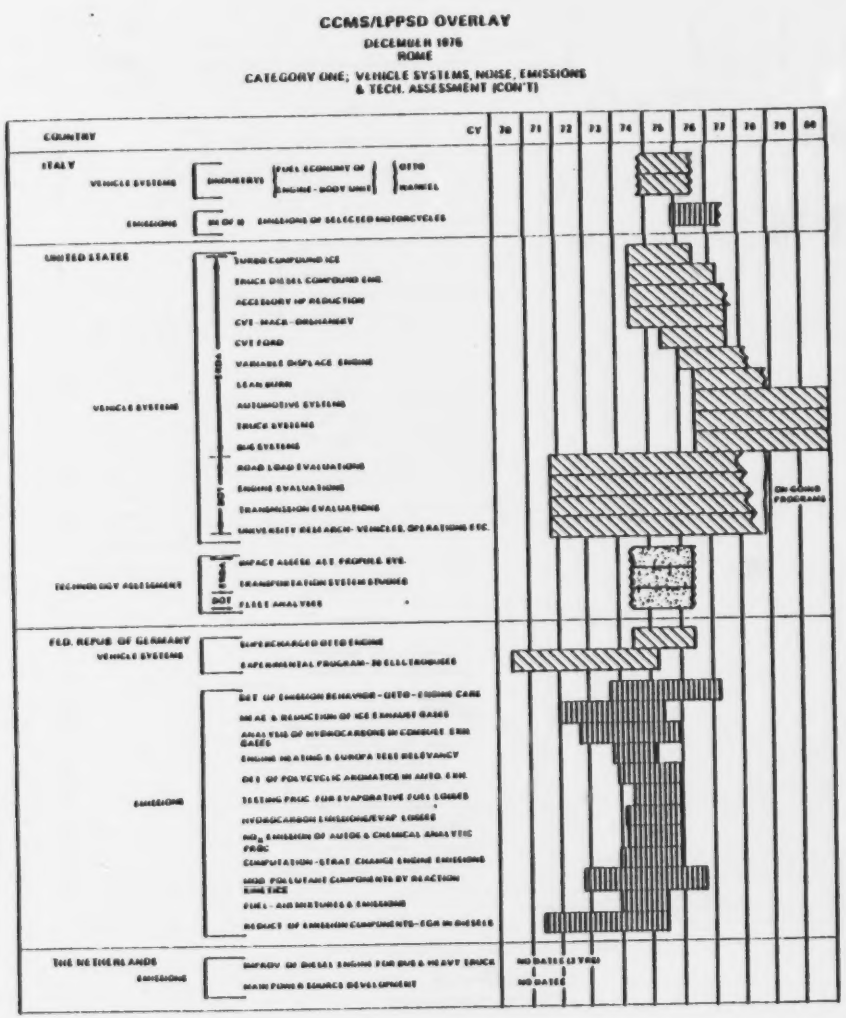
4. High-Temperature Materials Research Project

Based on the results of the Pilot Study, a multilateral project on high temperature materials (ceramics) for APS has been planned and could be carried out under the auspices of the IEA.

5. Influence on National Programs

Through exchange of information, national APS programs were modified. Some examples are: 1) the U.S. increased its efforts to reduce automotive noise; 2) there was renewed effort to "harmonize" automotive emissions controls; and 3) the U.S. increased its R&D in Stirling engines.

FIGURE 3.11
1975 APS Report Results



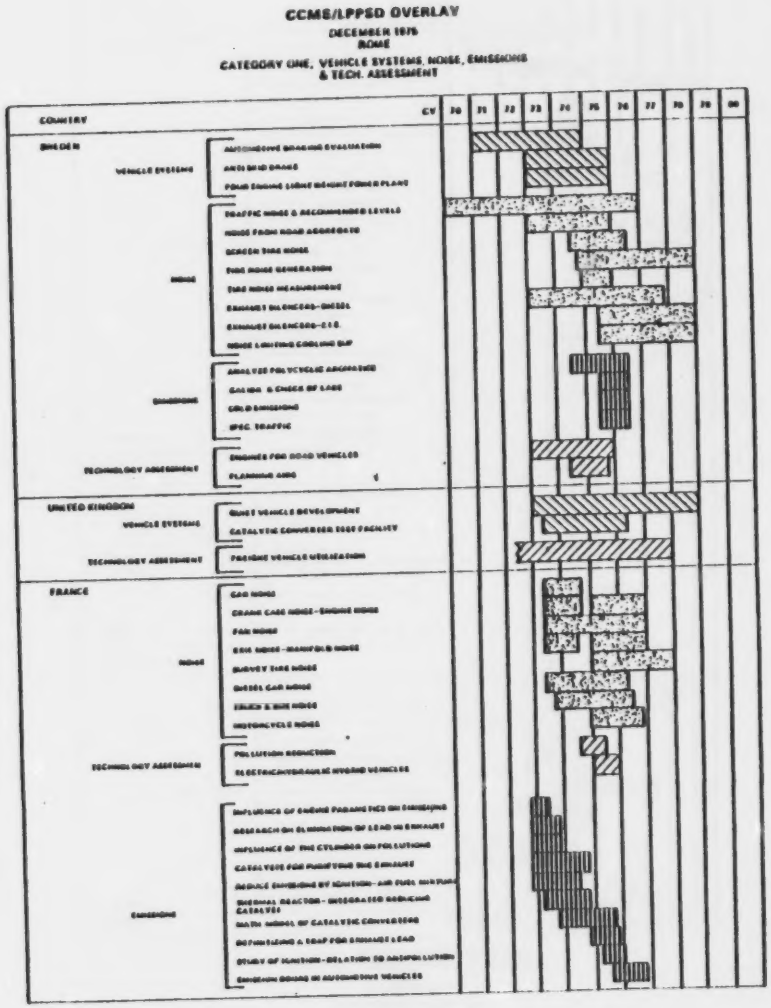


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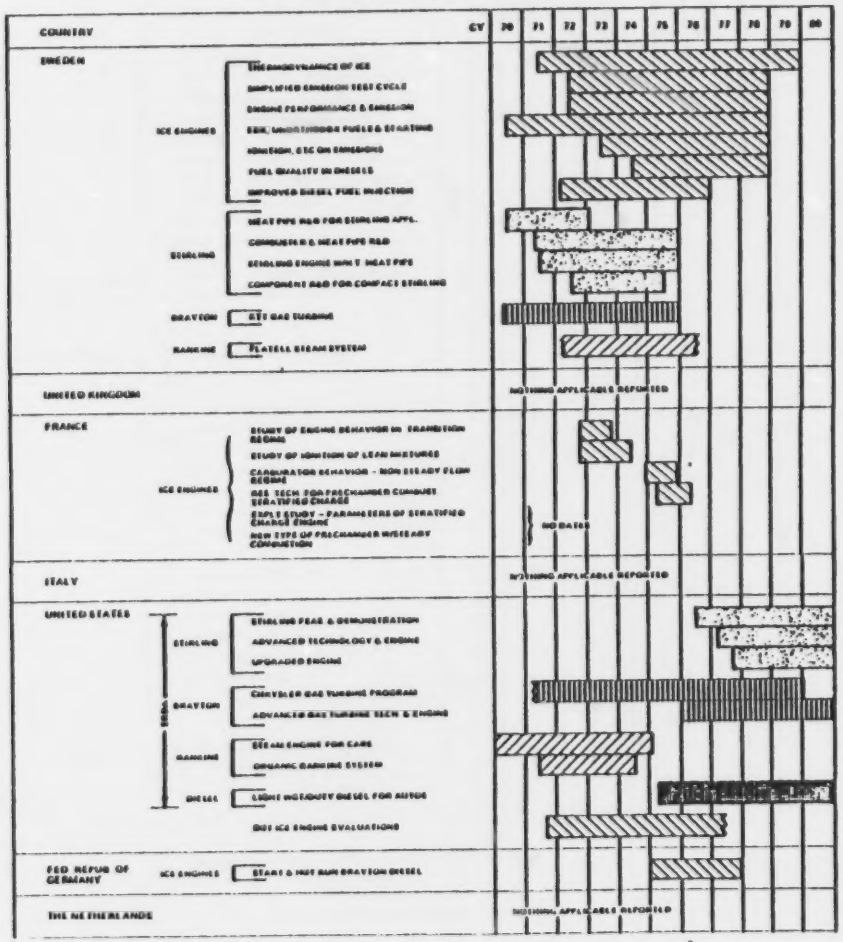
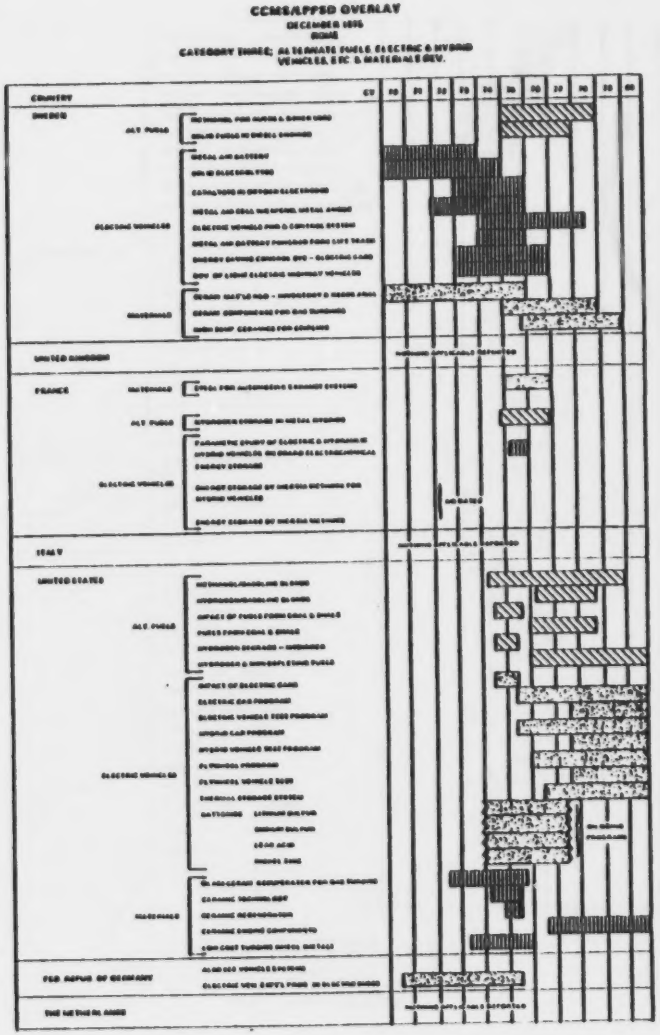
FIGURE 3.11 (Continued)
1975 APS Report Results





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3.4.2 Resolutions and Recommendations

The pilot study developed the following resolutions and recommendations.

1. National Action

   The pilot study resolved that nations should continue and increase R&D efforts toward development of new and improved energy-efficient and environmentally acceptable engine systems. This would include budget reviews to insure proper funding support. In addition, the Pilot Study encouraged participation in national APS R&D programs of all national agencies.

2. International Collaboration

   The Working Group recommended continued international collaboration to be carried out by existing international organizations or through ad hoc bilateral or multilateral agreements. Procedures for accomplishing this were recommended. One important recommendation is that all participating countries in any collaborative program provide both funds and effort to the program.

3. Areas of Technical Emphasis

   The Working Group considered the following areas as offering potential for successful international R&D efforts. In addition, the Working Group recommended that future international R&D efforts focus on narrow, technical issues.

   - Power systems and components.
   - High temperature materials.
   - Alternative fuels
   - Electric and hybrid vehicle systems.
   - Emissions from diesel engines.
   - Development of compatible emission regulations.

4. Symposia

   The Working Group recommended that the biannual symposia continue under a rotating sponsorship.

5. Technical Contacts

   The Working Group recommended that the contact list be kept current through annual updates.

4. INTEGRATION OF THE FOUR CCMS ENERGY PILOT STUDIES

Each Pilot Study was designed and conducted as a separate effort. There was no attempt to link the studies until they were essentially concluded. In July, 1978, the governments of Italy and the United States sponsored a meeting for the Pilot Study leaders and other international energy policy experts. Thirty-one participants from seven countries and the International Energy Agency, NATO/CCMS and the NATO Science Committee took part. The purposes of the meeting were to:

1. Review the results of the Pilot Studies.
2. Discuss the interrelationships among the findings of the different studies.
3. Develop recommended follow-up activities on both national and international levels.
4. Identify the lessons learned that would strengthen future efforts in international cooperation.

This section of the report resulted from the discussions of the Integrating Group.

4.1 CENTRAL THEMES

In general, the Integrating Workshop found that in several areas, especially energy conservation and the interface of energy and environmental issues, a broad-based, non-political international forum could help stimulate further action. Such a forum would serve to focus public attention on the discrepancy between current practices and what is possible and practical to achieve with increased awareness and determination.

4.1.1 The Main Theme - Conservation

While the studies generally focused on rather narrow, technical issues, the concept of conservation was the dominant overall theme. It was expressed in several ways:

- Conservation of fossil fuels through increased use of alternative or renewable energy sources.

- Conservation through improved management of energy-using processes.
- Conservation through development of more energy-efficient processes by national and international R&D.
- Conservation through intelligent use of existing technology to improve efficiency of energy-using systems.

Inadequate Existing Programs

In general, the Integrating Group participants concluded that current national and international programs for energy conservation were inadequate for achieving the large potential which they felt exists. Almost all of the recommendations of the studies emphasize the need for increased effort in the areas of conservation outlined above.

A Conservation "Ethic"

In conducting the studies and developing recommendations for follow-up actions, the need for energy conservation became clear. Concepts were developed based on the recognition that it is necessary to insure that the maximum practical amount of usefulness to society is obtained from every unit of energy used. Some examples are listed below:

- Geothermal
  - Brine re-injection to prolong reservoir life.
  - "Cascading" systems.
  - Hybrid geothermal/fossil fuel systems.
- Solar
  - Zero Energy House Group.
- Rational Use of Energy
  - Industry sectoral studies.
  - Integrated utilities (MIUS).
  - Electricity load management.

- Automotive Propulsion Systems
  - More efficient engines (turbine, etc.)
  - Alternative fuels.

If any single lesson can be learned from the Pilot Studies it is that each nation should re-evaluate its programs with a view towards achieving a substantially higher degree of energy conservation.

4.1.2 Non-Technological Aspects of Energy Programs

Figure 4.1 is a flow chart of the process of developing a rational and effective energy program, with examples from the Pilot Studies and other international activities. Few, if any, programs can proceed from problem perception to successful implementation along route (A) which deals with the technological aspects of the program only. Most programs must also deal, at some point, with the non-technological aspects (route B) such as:

- Economics and financial barriers.
- Sociocultural (lifestyle) issues.
- Existing legal and institutional framework.
- Environmental impacts.
- Inertial resistance to change.

As shown in Figure 4.1, as the perception of the non-technological issues increases, the basic definition of problems and the programs for solution must be modified.

With few exceptions, the Energy Pilot Studies did not deal with non-technological issues for several reasons:

- As Mr. Train's statement shows, NATO members began the studies in response to perceived non-technological needs (environmental protection, conservation). The subsequent perception of additional non-technological issues is a "second order effect."
- At the beginning of the studies, participating nations did not perceive a commonality of interest in the non-technological areas necessary for international action.

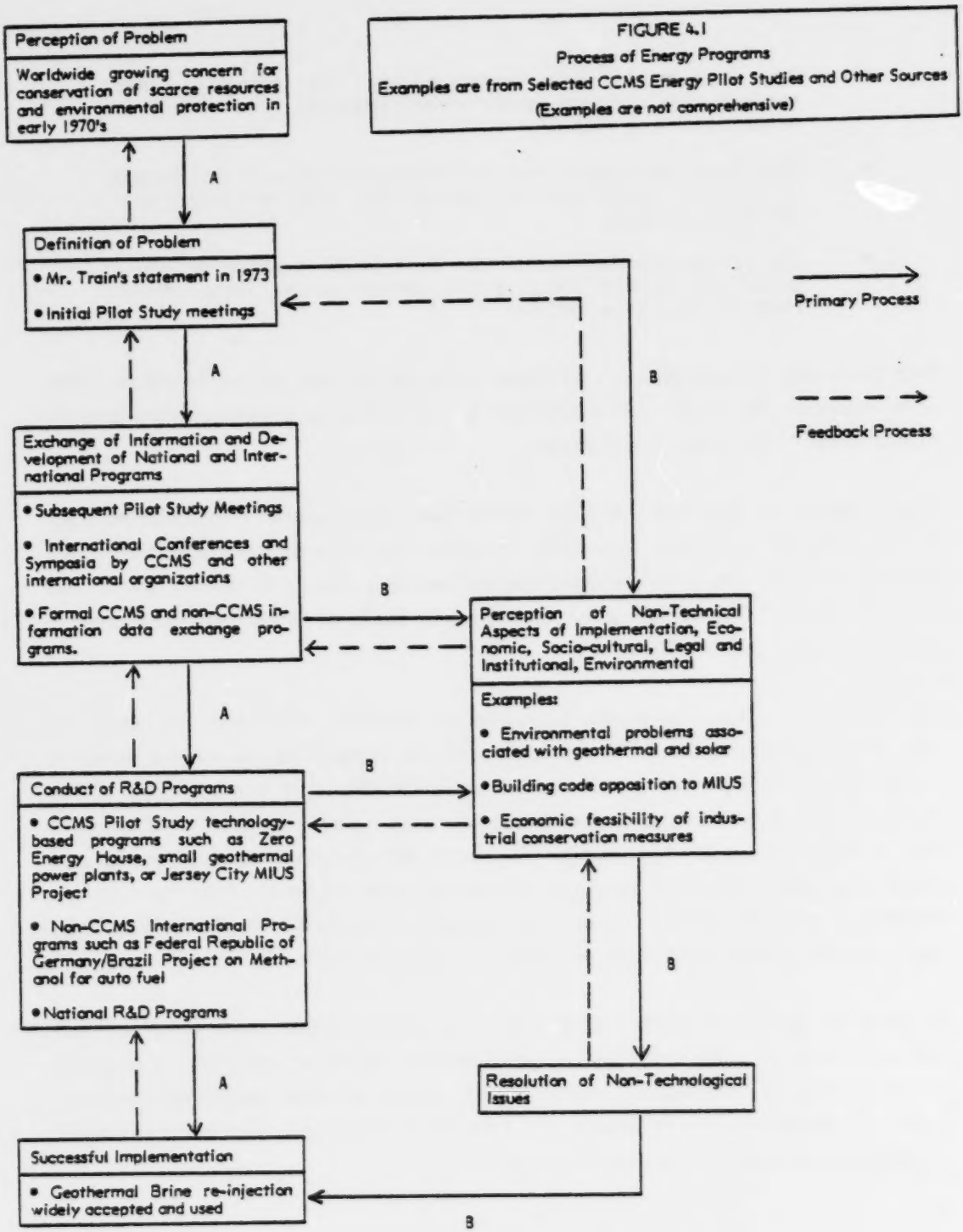
Perception of Problem
Worldwide growing concern for conservation of scarce resources and environmental protection in early 1970's
A
Definition of Problem
• Mr. Train's statement in 1973
• Initial Pilot Study meetings
A
B
Exchange of Information and Development of National and International Programs
• Subsequent Pilot Study Meetings
• International Conferences and Symposia by CCMS and other international organizations
• Formal CCMS and non-CCMS information data exchange programs.
B
Perception of Non-Technical Aspects of Implementation, Economic, Socio-cultural, Legal and Institutional, Environmental
Examples:
• Environmental problems associated with geothermal and solar
• Building code opposition to MIUS
• Economic feasibility of industrial conservation measures
A
B
Conduct of R&D Programs
• CCMS Pilot Study technology-based programs such as Zero Energy House, small geothermal power plants, or Jersey City MIUS Project
• Non-CCMS International Programs such as Federal Republic of Germany/Brazil Project on Methanol for auto fuel
• National R&D Programs
A
B
Resolution of Non-Technological Issues
Successful Implementation
• Geothermal Brine re-injection widely accepted and used
B
Primary Process
Feedback Process

FIGURE 4.1

Process of Energy Programs

Examples are from Selected CCMS Energy Pilot Studies and Other Sources

(Examples are not comprehensive)

- Pilot Study participants determined that the technology issues required more complete understanding before the non-technological issues could be addressed.
- Pilot Study participants were primarily technically-oriented experts with little experience in articulating and analyzing non-technological issues.
- The non-technological issues vary from nation to nation depending on cultural, political and geographic circumstances. Thus, common solutions may not be possible.

Pilot Study and Integrating Group participants agreed that the non-technological issues were important and should receive emphasis both in follow-up activities for the present studies and in future international studies.

It is important to note that the Pilot Studies were very successful in achieving their limited goals and objectives. Any effort to expand the scope of the studies might have resulted in dilution of available resources and less high quality of results. In fact, an effort by the MIUS substudy group to develop a paper on "Incentives and Barriers" encountered considerable difficulties.

The Integrating Group developed a conceptual approach which may be useful in approaching future studies. The approach involves completing the matrix shown in Figure 4.2 at different phases of development of a project. Within each cell of the matrix, a definition of the issues and their importance, a statement about what is known and not known about the issue, what information and analysis (if any) is necessary to resolve the issue and current efforts to resolve the issue are listed. Once the matrix is prepared, a project is designed to achieve successful implementation. Periodic reviews, again using the conceptual matrix, will keep the project on track.

By using the conceptual matrix, it is possible to identify those issues which are best addressed internationally and those for which national efforts are required. In all cases, mutual sharing of information, internationally, can be of great assistance. In many cases, the realization that an issue is important and complex for several nations is useful in developing successful programs domestically.

FIGURE 4.2

CONCEPTUAL APPROACH TO
PROJECT ANALYSIS

PROJECT STAGE	TECHNICAL ISSUES	LEGAL, INSTITUTIONAL & REGULATORY ISSUES	ECONOMIC ISSUES	SOCIOCULTURAL, ATTITUDINAL & LIFESTYLE ISSUES	ENVIRONMENTAL ISSUES
Project Perception					
Project Definition					
Research & Development					
Demonstration					
Implementation or Commercialization					

4.1.3 International R&D

The Integrating Group found the following benefits for national governments from their participation in international R&D:

- Repeats of failures are avoided.
- The political and economic risks are shared.
- Solutions to problems are achieved more quickly.
- Redundant research is avoided.
- Expenses are shared.

There is no evidence that international R&D reduces the cost of an overall national R&D program such as that for energy. However, the efficiency of the programs can be improved. While budgets may remain constant, accomplishments should increase.

4.1.4 Different International Approaches

The Integrating Group found that different types of approaches are necessary for different types of international programs. In some cases, very formal approaches are necessary to insure complete understanding and acceptance. In other cases, formality impedes progress. In some cases, problems can be dealt with on a regional basis; in other cases, a cross-regional approach is necessary.

Within the international context, CCMS-type approaches are particularly useful in the following circumstances:

- When the problem is just emerging as an international issue; or when the problem is poorly understood.
- When information on national activities is not widely available internationally.
- When flexibility as to membership is necessary. This includes both which nations should participate and which types of experts should be involved.
- When national policies are not fully developed.

This type of approach has been used successfully by other international organizations such as the IEA in defining and developing programs.

4.2 LESSONS LEARNED AND RECOMMENDATIONS FOR PRESENT AND FUTURE INTERNATIONAL ENERGY STUDIES

4.2.1 The CCMS Approach - Lessons Learned

The CCMS approach proved very useful in conducting the Energy Pilot Studies. The voluntary, informal approach was especially useful in encouraging problem definition and program development. Some of the perceived strengths of the approach are:

- CCMS is a catalyst for many emerging issues.
- The informal approach allows free discussion of failures as well as successes. In many cases, information on unsuccessful programs is as useful as information on successful programs.
- The participation of non-NATO nations is valuable. In many cases, non-NATO nations possess valuable experience and expertise (e.g., New Zealand in geothermal energy). The participation of developing nations is especially important since it allows a channel for participative assistance.
- The voluntary aspect allows varying degrees of participation depending on national interest. Nations which do not have an on-going program can participate along with those with substantial programs.
- Through "subprojects," several related, but different, projects can be undertaken by the same pilot study. This allows the specific concerns of participating nations to be addressed.

4.2.2 Information Sharing

Information resulting from the Pilot Studies is shared in many ways. These include:

- Informal sharing among participants of Pilot Study meetings, conferences and symposia.
- Official CCMS publications of the reports of the Pilot Study (see appendix). These are available to anyone who requests them.
- Sharing (depending on national policy) of national reports, memoranda and other documents resulting from the Pilot Studies.

In general, the participants of the Integrating Group felt that the results of the Pilot Studies should receive much wider distribution in order to achieve an impact on national and international policies. There are differences of opinion about the approach nations should take in the dissemination of materials developed in international projects. The

majority of the participants supported the concept of informal exchanges among technical departments in all participating nations.

The process of information sharing has two parts—collection and dissemination. These are discussed separately below.

Information Collection

Each Pilot Study developed a method for formally collecting information from participants. For the following Pilot Studies, the information collection process is planned to continue under other multilateral arrangements.

- The computerized geothermal information base being maintained by Italy and the United States.
- The Solar Energy reporting system.
- The memorandum-of-understanding for solar energy information exchange is continuing.

While the following Pilot Studies recommended continuation of the information collection process, no mechanism for doing so was recommended. These are:

- The MIUS Project Catalog.
- The APS Reporting System.

Information Dissemination

In conducting future Pilot Studies, the Integrating Group recommends that three separate contacts be established in each participating nation. These would be:

- An official government contact.
- A technical representative.
- An information system contact (e.g., national technical library)

Results of CCMS Pilot Studies could be shared with all three sources. This approach was used by the Solar Pilot Study with success.

For some Pilot Studies, it is necessary to identify non-government contacts and provide information directly to them. For example, the APS Pilot Study devoted considerable effort to identifying appropriate industry officials who might utilize the results of the study. In circumstances where proprietary or confidential data is being used (see Section 4.2.3) this approach is essential.

In general, the Integrating Group concluded that existing information sharing mechanisms were inadequate. The effectiveness of various national information distribution systems within the international network was identified as an issue which merits further discussion and development. The following means of sharing were discussed.

- Making all reports available through NTIS, operated by the U.S. Department of Commerce, available worldwide.
- Active participation by delegates to the CCMS Plenary sessions in disseminating the information.
- Development of a plan for disseminating information as part of the work plan or design for the Pilot Study.

Role of Information Sharing and Implementing New Technology

The Integrating Group expressed concern that the current emphasis on the international energy situation may result in "overselling" emerging technologies. This could result in attempts to commercialize immature technical developments which could fail. Such failures could seriously impede further R&D due to fears of additional failure. This concern was expressed specifically for implementation of geothermal and solar applications.

Complete information on both the positive and negative aspects of a technology is essential for decision makers to avoid failures. Education and information availability for policy analysts, financial insititutions and investors is a critical part of successful implementation of a new technology.

4.2.3 Proprietary or Confidential Data

Because of their economic importance and profit potential, many aspects of the energy system involve data which is considered proprietary or confidential. In general, such data is kept private due to:

- High profit potential.
- Desire to avoid government regulation or taxes.
- Desire to improve the competition of one nation versus another.
- Inability to obtain enforceable patents or other international legal protection.

Depending on the degree of government-industry cooperation, more or less private data is voluntarily divulged to government.

In some cases, the Pilot Studies were not able to obtain confidential data. The APS and Industrial International Data Base studies encountered the most difficulty. For APS, the reluctance of the automobile industry to divulge short to medium term plans (up to 10 years) is well known. For the data base project, the plastics industry was especially reluctant to divulge information. Many private sources were concerned about the ability of the U.S. Government to protect proprietary data in light of the Freedom of Information Act which requires release of most information held by the government.

Some solutions to this problem suggested by the Integrating Group were:

- Encourage direct exchange among industry officials without government participation.
- Provide valuable information to industry in exchange for some confidential information.
- Compile and release all publically available data. If industry finds it inadequate, it may respond. This has been useful in U.S. energy conservation programs.
- Attempt to separate out proprietary issues so that attention is focused on areas where data and information are available.

4.2.4 Funding and Participation

In general, funding for a CCMS pilot study is provided by the participating countries. This funding mechansim is advantageous because it insures that each participating country has sufficient interest in the program to provide funds. This, in turn, insures motivation to complete the study.

Pilot Study participants who do not provide funding have less incentive for active participation. While participation by most nations in the Energy Pilot Studies was very good, the Integrating Group found that those with a stake in the outcome were more productive than those who simply observed. These nations also seemed to benefit more.

Funding is not the only means of encouraging active participation. Participating nations can serve as host countries for Pilot Study meetings, conferences and symposia such as Germany and Italy for APS symposia. They can "donate" a national project to the Pilot Study such as the "Zero Energy House" from Denmark or the Visiting Scientist Program for geothermal scientists at the Los Alamos Scientific Laboratory where the U.S. made available the facility and countries funded the scientists. Finally, they can provide the national support for a project such as the portable small geothermal power plant in The Azores, Portugal.

The Integrating Group recommends that the voluntary participation of CCMS studies continue; but that participants be encouraged to agree, as part of the design of the work plan, to devote either funds or resources in order to achieve the best results.

4.2.5 Expanded Professional Participation

Most participants in the Pilot Studies are government employees. While their participation is essential, the Integrating Group felt that increased participation by experts from industry and academia would improve the quality of the work and assist in the implementation of the recommendations. The expanded participation could also assist in obtaining release of confidential data and in disseminating the results of the study.

4.2.6 Validation of Accomplishments

The Integrating Group found that most Pilot Studies did not maintain an accurate list of the accomplishments in all participating nations of the study. Such a listing is desirable to appraise the success of a study, to define deficiencies in the study and develop recommendations for follow-up work. The official follow-up period for the four Energy Pilot Studies can be used to validate results. In the future, a plan for validation could be included in the original design of a study.

4.3 RECOMMENDED AREAS FOR FURTHER INTERNATIONAL COOPERATION ON ENERGY

The recommendations of each Pilot Study are summarized in Section 3 of this report. In addition, they are presented in detail in the final report of each Pilot Study. This section contains a listing of other areas that the Integrating Group found could benefit from further collaboration in one or more existing international forums.

4.3.1 Geothermal Energy

Environmental Impacts

The environmental impacts of geothermal energy projects are a major concern which must be resolved before widespread use can be achieved. An international project to define the environmental impacts, to compare data and information on measured environmental effects, and to study successful and unsuccessful abatement projects could assist in resolving this problem.

Seismic Effects of Geothermal Projects

In some cases, extraction or re-injection of geothermal fluids could induce seismic activity. The Integrating Group recommends that the CCMS Pilot Study on Seismicity and Earthquake Loss Reduction consider this problem.

U.S. - Mexico Bilateral Geothermal Agreement

The bilateral agreement between the U.S. and Mexico provided for an extensive research effort at the geothermal field at Cerro Prieto, Mexico. The Integrating Group recommends that Member Nations which are interested in the development of geothermal energy consider joining the project. Additional participants are encouraged by both countries.

Areas for Additional Geothermal R&D

The Integrating Group identified the area of direct use of geothermal energy with special emphasis on hybrid systems (e.g., goethermal/coal) as offering potential for a multilateral R&D program. This project could be sponsored by an appropriate international organization.

4.3.2 Solar Energy

Passive Systems

Passive solar systems are those which rely on architectural design, siting, natural ventilation and other non-moving hardware for delivery of the work or service provided by energy. Such systems do not have active, effective proponents in many cases since the sale of a product is not usually involved. However, such systems have potential for use in residences, industry and agriculture. An international project focusing on information exchange and implementation of passive systems may produce positive results.

4.3.3 Rational Use of Energy (Conservation)

The Pilot Study pointed out various levels of intervention for achieving energy conservation in industry. These include simple, one-time capital investments such as adding insulation to pipelines or tanks, managerial changes such as modifications to operating procedures for better process control, and major changes in processing technology by the construction of entirely new facilities. The Pilot Study was not able to focus on all these levels as part of its investigations. The Integrating Group recommends that the methodology as developed be applied to additional industrial situations and that measures to save energy be ranked according to the type of intervention required. This ranking could assist management in making decisions on cost-effective steps to improve energy utilization.

4.3.4 Automotive Propulsion Systems

Intermodal Systems

CCMS and other international studies have addressed the fuel consumption and emission characteristics of engines and engine components. There is now a need to address the energy and environmental aspects of various other parts of the transportation system. This would include an assessment of the technical and non-technical aspects of intermodal shifts (e.g., automobile to bicycles for commuting) as well as bimodal systems (e.g., automobile-rail combinations).

4.3.5 Bilateral and Multilateral Agreements

In developing international agreements, the Pilot Study participants found very little guidance available to them. They recommend that an international organization undertake to develop a checklist of issues to consider, a set of standard clauses and model agreements and protocols for use in drafting future energy R&D and information exchange agreements. Special attention should be paid to developing methods which easily accomodate the addition of nations which desire to participate after an original agreement is signed and the original participants desire their addition.

4.3.6 Lessons Learned From Dealing with Emergency Energy Situations

The Integrating Group found a need for international information exchange on describing and validating techniques used by national authorities in circumstances with serious disruptions in energy supply. Examples of this may include experiences during the recent New York City blackout or the U.S. blizzard of 1977, or recent "gasless Sundays" in Europe.

4.3.7 Integrating New Technologies Into the Existing System

The methods and timetable for integrating new energy technologies into the existing system are poorly developed and little understood. There is a need for further international study in this area which includes theories for organizational and societal changes, identification of institutional barriers, and the encouragement of technological and systems evolution.

4.3.8 Availability of Experts

The Integrating Group found that all nations could benefit if experts on various new techniques and technologies were readily available for short-term, multilateral consultations and exchanges of experience on specific issues.

5. AN EMERGING ISSUE - DESIGNING TECHNOLOGY FOR HUMAN SOCIETY

Each of the four Energy Pilot Studies dealt with specific aspects of a particular technology or concept. They were designed to meet needs perceived at the time of design, but perceptions of need change with circumstances. A review of the work accomplished by the Pilot Studies and Integrating Group indicates that to take the greatest advantage of the results, it is necessary to re-examine the directions of our technological development. Both solar and geothermal energy sources, as well as sites for energy conservation, are dispersed. Thus, they are not appropriate, in many cases, for large centralized facilities. The rational use of energy requires viewing our energy consumption patterns in a holistic way, taking into account all aspects of our styles of life (economic, environmental, social, cultural) and integrating them carefully in the development of new systems. This leads us to an emerging new challenge to modern society—the apparent need to more systematically and consciously build human considerations into efforts that have in the past primarily focused on solving problems in a purely technical way. Concern for a new technology's contribution to human values and institutions should become an integral part of future international cooperation.

The traditional conflict between the demands of ever increasingly complex and large-scale technologies with the needs of their human user is beginning to be resolved in several new ways, including decentralization of some functions and facilities, application of state-of-the-art technology for miniaturization of systems, and adoption of small-scale technology. Examples include the use of the MIUS concept for a neighborhood facility for solid waste disposal instead of such a facility for the entire city, the use of passive solar systems for residential heating and cooling, and the use of small goethermal power plants.

While many of the Pilot Study participants came face to face with this issue when considering problems of implementation, none of them dealt explicitly with it. The questions of complexity and size, institutional barriers, side effects of implementation, and relevance to local requirements, go beyond the boundaries of any one technical study. In fact, the central issue goes well beyond the boundaries of energy R&D in general. Yet the answer does not lie in decreasing our efforts at technological innovation.

5.1 SUITABLE TECHNOLOGY

Technological innovation is responsible for bringing about great advances in mankind's standard of living and creating the complex, interdependent economic systems of today. However, both costs and benefits of the technological revolution are well documented by astute observers of our current state. In the continuing evolution of technological innovation, we are now coming to realize that some of the problems associated with current applications can be solved by taking into account more fully different attitudes about economic growth, the relative roles of labor and capital, environmental impacts, socioeconomic effects, and other influences on the quality of life.

Suitable technology (sometimes referred to as "appropriate technology") includes the concept of designing a technological application (including its size and complexity) to fit the overall circumstances to which it will be applied. The concept is equally applicable in developed and developing economies. Examples include using windmills for pumping irrigation water, using bicycles for urban transportation, or allocating low intensity energy sources (such as direct geothermal application) to low heat requirements.

Many applications of suitable technology have proven useful in developing countries. It is now apparent that application of the concept may also be useful in industrialized nations. Less industrialized nations may be able to provide techniques which are useful in highly industrialized countries. Examples might include building designs with passive systems and alternative materials (e.g., adobe bricks) that take greater advantage of solar energy and conservation concepts. In some cases, developing and developed nations may join to develop new applications. A good example of a joint effort is the Federal Republic of Germany-Brazil joint project on using biomass for production of methanol as an alternative automobile fuel.

The challenges of this perspective are to create new technologies and adapt existing ones in order to better satisfy the needs of society, not as an aggregate, but in its many local variations. In developing the suitable technologies, it will sometimes be necessary to modify existing economic, social and governmental systems to allow implementation. These changes could range, for example, from amended building codes to allow for energy conservation devices to amended governmental regulations affecting financing of energy systems for agricultural irrigation.

Several nations and international organizations have begun suitable technology programs. In the United States, the U.S. Department of Energy has begun an appropriate technology program in several western states; U.S. AID has begun programs in developing countries; and the State of California has begun a program. The stage of growth of these programs is roughly analagous to that of solar and geothermal at the beginning of the CCMS Pilot Studies in 1973. The subsequent success of the geothermal and solar studies suggests that now is the opportune time for multilaterial action on the subject of suitable technology.

5.2 AN AGENDA FOR DISCUSSION

The themes stated by Mr. Train at the beginning of the Pilot Studies remain—an international concern for diminishing resources, conservation (especially of fossil fuels), and environmental protection. What has emerged is a new dimension—the theme of harmonizing technology through a wider perception of human needs and values. The Pilot Studies and the Integrating Group all pointed toward development of decentralized and small-scale energy systems; simplified (but possibly technically elegant) methods for developing, delivering and using energy; applying "high quality" energy (natural gas or electricity) to the most necessary uses; and reducing the complexity and vulnerability of the entire energy system. In the past, we progressed by overcoming natural and social forces to meet our needs. Now, there is an emerging need to adapt technological systems to the limitations of the economic, geographic, environmental, cultural and social systems in which we exist.

APPENDIX

CCMS Energy Pilot Study Reports

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